Compressed Air Magazine

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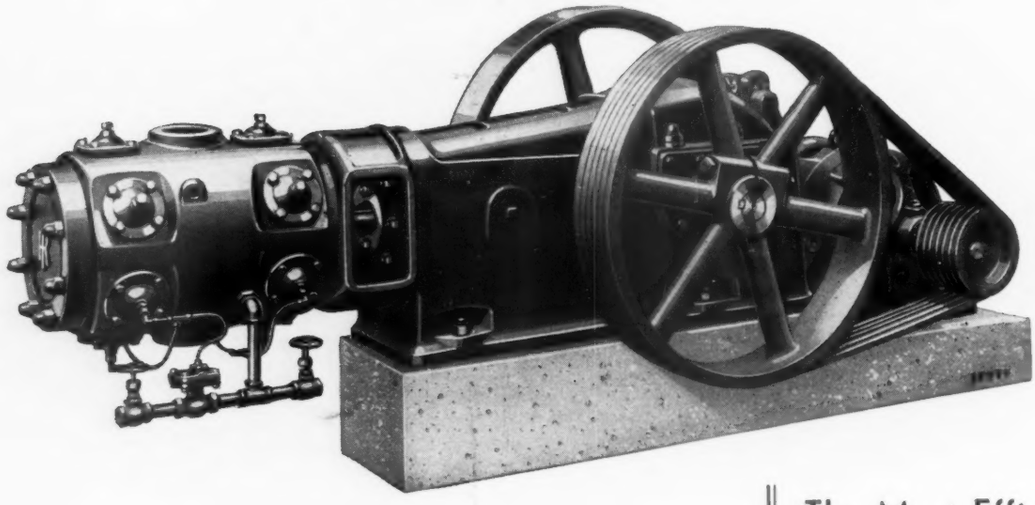
YOU NEED AN "ES" COMPRESSOR



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As It Seems To Us

APPROACHING ABSOLUTE ZERO

BY adapting to his purpose the peculiar properties of gadolinium sulphate octahydrate, Prof. W. F. GIAUQUE of the University of California has succeeded in creating a temperature of —272.75° Centigrade, which is within one-fourth degree of absolute zero. Gadolinium is a rare element whose compound, used in this work, becomes warm when it is magnetized. By repeatedly magnetizing it and then extracting the heat, it is possible to do the same thing as when compressing a gas and allowing it to expand.

In establishing this new low record for frigidity, Professor GIAUQUE first cooled the gadolinium compound to —1.88° C. by ammonia refrigeration. He then magnetized the substance and removed the heat with liquid helium. By performing this cycle over and over, he attained the lowest temperature ever achieved. Previous attempts to reach absolute zero were made by compressing and decompressing helium alone. At —273° C., scientists believe, there is no movement of the molecules in matter, and hence no heat.

HOOVER, BOULDER, OR BLACK?

ON May 14, past, the Associated Press announced that HAROLD L. ICKES, Secretary of the Interior, had issued an order changing the name of Hoover Dam to Boulder Dam. In a letter printed in the *New York Herald-Tribune* on May 26, Mr. ICKES denied that he had taken such action—in fact, revealed that he was not even in Washington on May 13 or 14 and that he had neither issued any statement with regard to the dam nor talked to any correspondent about it. He did, however, very clearly indicate that he was in sympathy with the reported change of name and even stated that he had always referred to the structure as Boulder Dam and would continue to do so.

It is not our intention to discuss the controversial angles of the matter; but, inasmuch as we are running a series of articles on the undertaking concerned, we naturally desire to describe what we are writing about under its official name and shall await with academic interest any pronouncement that may be forthcoming from Washington.

In behalf of accuracy, though, it is pertinent to note that Boulder Dam is a misnomer, because the structure will not be erected in Boulder Canyon. The facts are these: By virtue of a joint resolution of Congress, the Colorado River Board was created on May 29, 1928, and among its duties was that of deciding where the dam should be built. Two sites were considered—one in Boulder Canyon and one in the upper part of Black Canyon; and the Black Canyon site was selected.

The Bureau of Reclamation, under whose direction the work is being done, originally gave the undertaking as a whole the name of Boulder Canyon Project, and has consistently used that designation since. When it came to christening the construction town that was reared in Nevada to house the workers, Boulder City was chosen. The word "city" was appended because there is a Boulder in Colorado and a lesser town of the same name in Montana. Unfortunately, this failed to eliminate confusion, as is attested to by the fact that not infrequently well-meaning but ill-informed writers or editors locate not only Boulder City but also the dam in Colorado.

OUR FRONT COVER

ROME'S Colosseum needs no introduction, as it is one of the world's best-known structures. Here we see a section of it during the construction of the Via dell'Impero, described in this issue, which is an approach worthy of this great amphitheater. It was built almost wholly of blocks of travertine held together by iron clamps and had a seating capacity of about 50,000.

THE REFORESTATION CAMPS

THE reforestation army that is deploying over the country may be termed a distress organization, inasmuch as most of those who compose it have been driven by force of necessity to enlist in that service. The first consideration of the Government is to give self-respecting citizens jobs which will enable them and their dependents to subsist. The work they will do will go to perpetuate a valuable natural resource.

Beneath the surface, however, there are substantial and lasting human benefits to be derived from the movement. Many of the young men who are entering the camps ignorant of the manner in which even the simplest hand tools should be used will emerge a few months hence with a fair working knowledge of various mechanical contrivances. Not a few of them will find themselves fitted to apply for work in lines which they never dreamed they might follow.

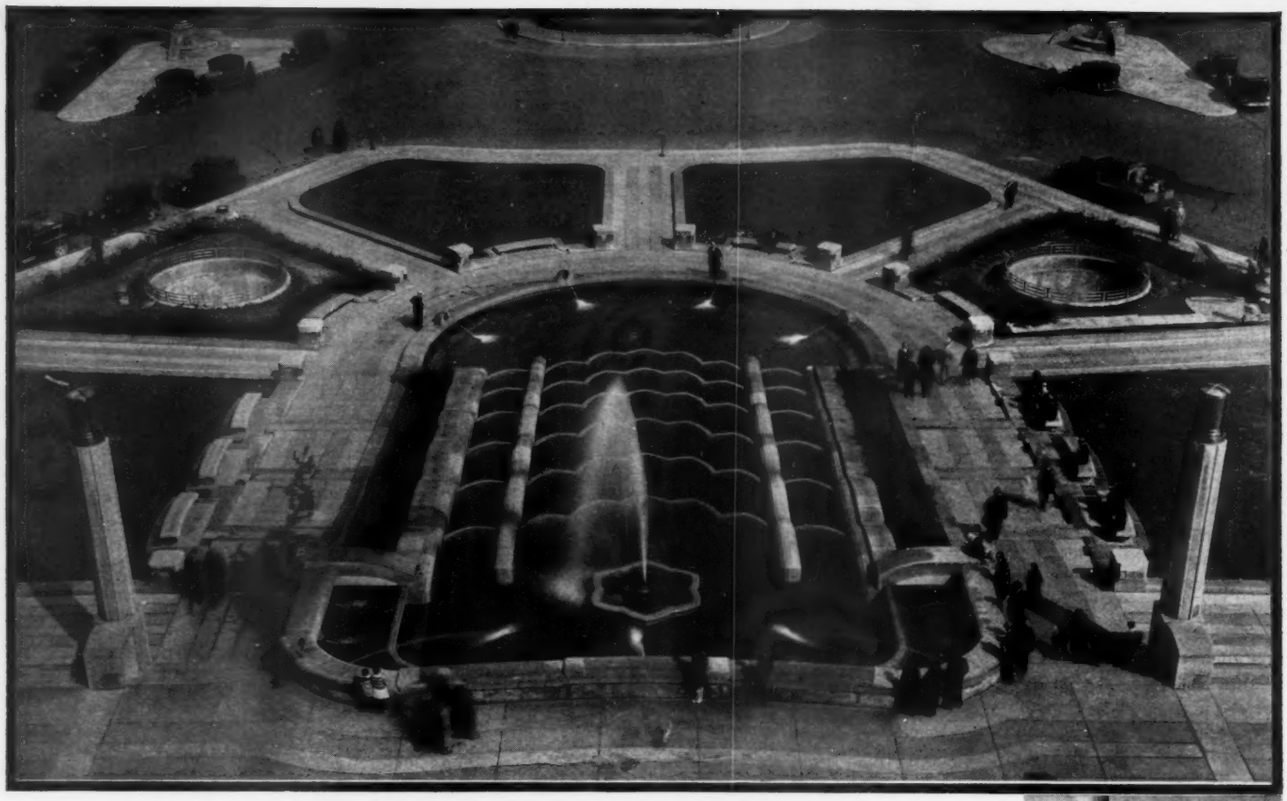
The task of clothing denuded hillsides with verdant woods means more than merely thrusting seedlings into the ground right end foremost. Buildings must be erected, roads and trails constructed. A hundred or more diverse activities are involved; and the average camp worker will learn much that may open the way to future employment. Among other equipment, air compressors and rock drills will come into play. Perhaps a collateral effect of the planting of these trees will be the training of a few hundred efficient drill runners who will take their places among the hard-rock men of mines and construction undertakings. It is pleasant to contemplate that, in addition to their dollar a day, large numbers of these rookie foresters will receive physical rehabilitation, a wholesome attachment for the great outdoors, a fresh zest for life, and a new insight into ways and means of keeping body and soul together.

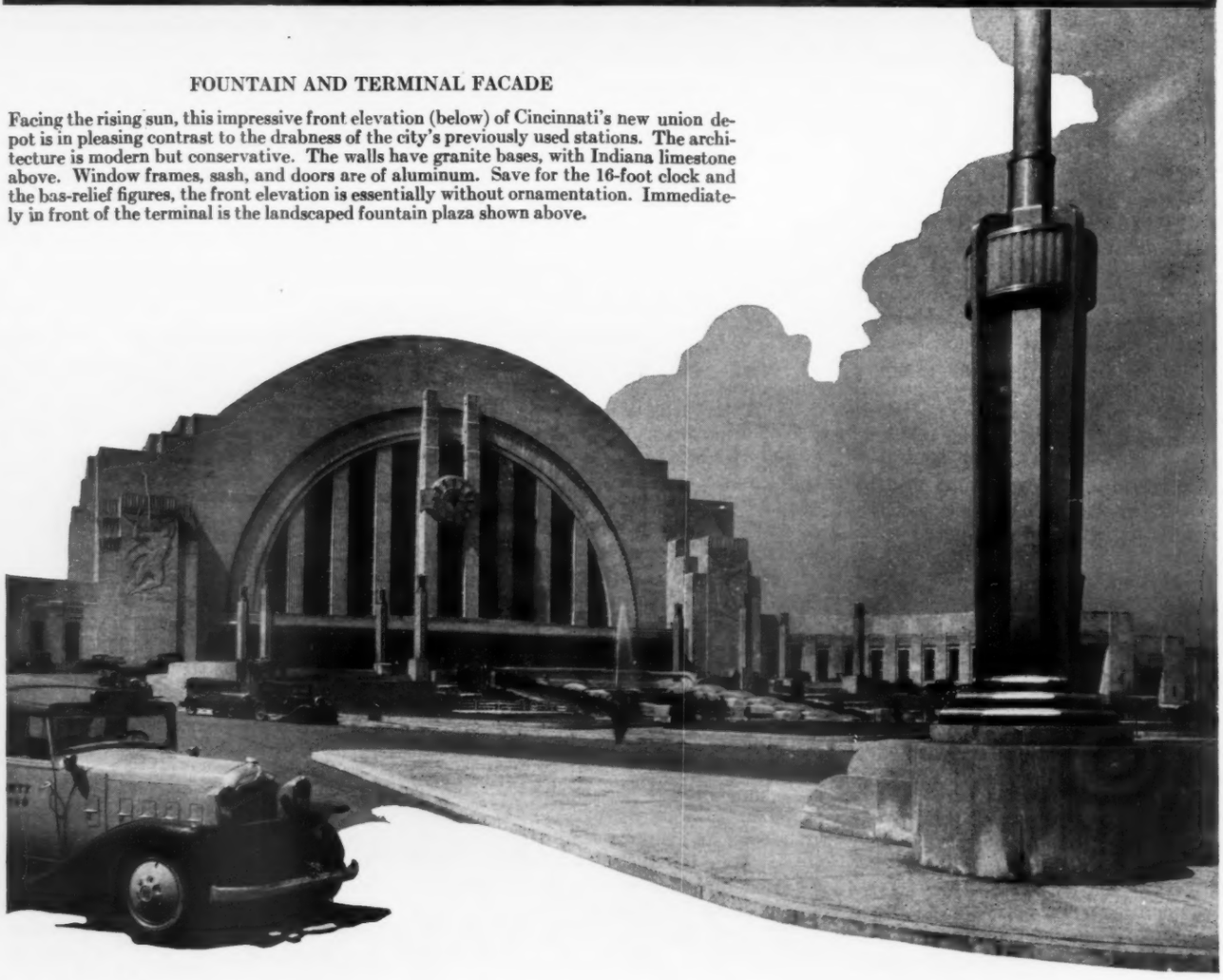
THE ARTIST PIONEERS

WE have been frequently told that artists are dreamers, and it is as such that the world at large has accepted them. So long as they have remained with their paints or their graving tools their creations have won plaudits; but when one of them has sought to delve in the realm of practical things, his usual reception has been little more than a complacent smile. And yet we read that one of the great railroad systems has placed an order for a 3-car, articulated train, streamlined and air conditioned, whose total weight will be less than that of a present-day Pullman. Surely, here the artist has crept into the counsel halls, for, in America at least, such radical departures from traditional practice have been confined to him.

Some two or three years ago one of the advertising trade journals published an article, by a commercial artist in New York, which described and pictured the author's conception of a train. His train had streamlines and conditioned air. It had the engineer stationed at the very front, where he might have the track in full view at all times. It had insulation to deaden the noise and shock from pounding and screeching wheels. No detail was overlooked which might improve the operation of the train or add to the comfort of its passengers.

Last winter another artist, NORMAN BEL GEDDES, well known for his commercial designs, published his *Horizons*, which contained studied suggestions for improving the appearance and utility of many articles, ranging from bottles to factory buildings. In his book there is an illustration of a train which bears a close resemblance to the newspaper pictures of the train that has been contracted for.





FOUNTAIN AND TERMINAL FACADE

Facing the rising sun, this impressive front elevation (below) of Cincinnati's new union depot is in pleasing contrast to the drabness of the city's previously used stations. The architecture is modern but conservative. The walls have granite bases, with Indiana limestone above. Window frames, sash, and doors are of aluminum. Save for the 16-foot clock and the bas-relief figures, the front elevation is essentially without ornamentation. Immediately in front of the terminal is the landscaped fountain plaza shown above.

THE STATION INTERIOR

Simple lines but rich, warm treatment characterize the interior. Expansive windows and indirect flood lights insure a wealth of illumination by day or night. The view above shows the towering windows of the facade and the sweeping lines of the semidome.

Seven Great Railroads Build a Union Terminal

R. G. SKERRETT

CINCINNATI now has in service a magnificent union terminal for the seven trunk lines that enter that city—the second largest municipality in Ohio. The terminal, which represents an outlay of $41,000,000, was officially opened with appropriate ceremonies on March 31, but it was actually used some days earlier because nature stepped into the picture and somewhat rudely upset the program. To be explicit, the flood waters of the Ohio River inundated one of the old stations and forced five of the railroads to run their trains in and out of the new station sooner than was scheduled. That situation, in part, explains why the Cincinnati Union Terminal was called into being.

The Queen City, as Ohioans like to call that bustling place, has heretofore had two railroad stations situated at opposite sides of the town. The Central Union Depot, erected in 1884, was used by five of the lines entering the city; and it stands in the midst of the industrial district and on the edge of the business center of the community. The Pennsylvania Station until recently used by three of the seven roads was built in the early "seventies." The apparent discrepancy in the number of the railways served by the terminals is explained by the fact that one of them made use of both depots. Between 1884 and 1930, the population of Cincinnati proper increased from 260,000 to more than 450,000; and within the metropolitan zone there are now some 750,000 people. Hitherto, because of its location, only one of the railroads serving the city made it a halting point on a through route—the other roads being forced to accept Cincinnati as a line terminal, with the associated traffic and operating handicaps. This state of affairs has resulted principally from physical conditions of the countryside.

The Valley of the Ohio River constitutes the easiest approach to Cincinnati; and immediate access for four of the railroads has been by way of Mill Creek Valley which traverses the city. Unfortunately, when the Ohio River is in flood Mill Creek is raised accordingly, and when this has occurred at intervals the Central Union Depot has been put out of service. Furthermore, the constricted paths of approach have repeatedly led to much loss of time—trains reaching the outskirts of Cincinnati on schedule have been delayed from a few minutes to an hour in reaching the station. As a result, passengers have been inconvenienced and postal and express services have been disrupted.

To point the way to betterment, the Cincinnati Railroad Terminal Development Company was organized more than ten years ago, and after due study presented a basic plan to the railroads concerned in 1923. Four years later the railways came to agreement; and, as a consequence, the development company was empowered to move towards effecting the needed improvement. Inasmuch as that company was not organized to construct a terminal, there was incorporated, in 1927, The Cincinnati Union Terminal Company for the purpose of selecting a site, approving plans for a terminal, and then carrying out the project. The immediate problem was to devise a scheme that would separate passenger and freight operations, and so do away with the confusion and delays incidental to the dual services of the available stations. Over a period of twenty months, plan after plan was developed and studied intensively by a numerous force of engineers.

Finally, an acceptable plan was devised—one that called for the building of a passenger station and an associate terminal capable of meeting existing requirements and those likely to arise for some time to come. It was, of course, indispensable that the scheme should contribute to economical operation. Of the $41,000,000 allotted for the execution of the project, $11,000,000 was to cover the purchase of the necessary land and $3,500,000 was to pay for the building of a 3,500-foot viaduct across thoroughfares blocked by the terminal property. While looking to the con-

MAIN CONCOURSE

Unobstructed save for the information kiosk in its center, the main concourse is a vast semicircular room approximately 175 by 125 feet in floor dimensions and having a maximum ceiling height of 106 feet. Recesses in its walls house eighteen ticket windows, lunch and dining rooms, telegraph facilities, and shops. Opening off the two opposing corners are a tea room and a small motion-picture theater. On the upper walls are mosaics on a heroic scale that depict the development of transportation.

venience of the railroads, it was equally essential that the interests of the city and its potential development should be given due heed; and this attitude has led to mutual benefits and to splendid coöperation between the railroads and the municipality.

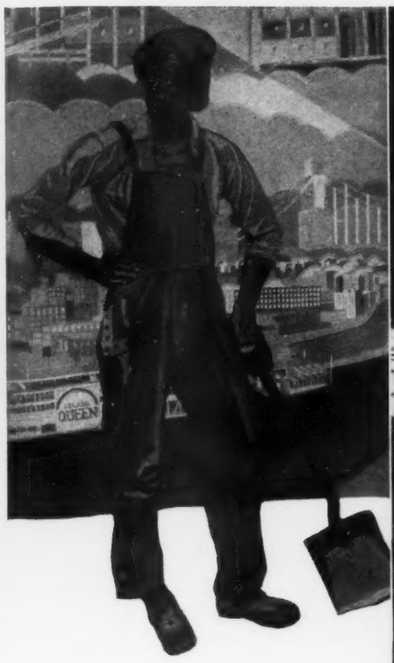
The Cincinnati Union Terminal is so located that it can function as a through station for all the roads that use it. Previously, only about 20 per cent of the trains entering Cincinnati passed onward after stopping there. The terminal is about three-quarters of a mile to the west of the old Central Union Depot and adjacent to Mill Creek Valley. It occupies a site of 287 acres, much of which was low ground that was inundated whenever the Ohio River rose to the 50-foot stage. To make the site safe and suitable, its general level had to be brought up 1 foot above the maximum recorded flood stage of the river—that is, to the 71-foot level. This involved the distribution of the enormous volume of 5,600,000 cubic yards of material; and at its highest point this fill has a vertical depth of 58 feet.

The greater part of the material was obtained from Bald Knob that lay nearby and west of Mill Creek. Bald Knob was a circular hill more than 200 feet in height and composed largely of hard shale with thin layers of limestone. It was purchased by The Cincinnati Union Terminal Company, which awarded to Winston Brothers Company, of Minneapolis, Minn., the contract for razing the hummock and providing the fill for the terminal site. Among other equipment, that concern used two 8-yard Marion steam shovels such as are employed in stripping operations. These progressively climbed the hill to as high as the 180-foot level and then cut it down—the topmost shovel clearing away the remaining 40-odd feet. The contractor hauled gravel from a borrow pit about fifteen miles distant from the terminal site, and there he also used a similar type of 8-yard shovel. The shovels had 85-foot booms and 52-foot dipper sticks. At the gravel pit, alone, more than 100 Western 30-yard air-dump cars were in service; and a large number of cars of the same make and size moved material from Bald Knob to the fill.

The fill is about 1,200 feet wide and 1½ miles long; and the gravel was placed principally under the terminal buildings and trainsheds where uniform settling was of the utmost importance. Because of the voids formed in the rock-filled area, which would have taken years for the shale to fill by disintegration, the cavities were packed by means of high-pressure water jets. About one-fifth of the volume of the fill was consolidated in this manner—settlement, amounting to approximately 12 per cent, being thus accomplished rapidly. The depth and the nature of the fill made it necessary to support the heavy structures upon strata lying well below the fill, and all told about 712,000 linear feet of piling was driven. The piles, numbering 6,300, are individually capable of sustaining a load

ONE OF THE RAMPS

for public vehicles that link the street with the lower level of the station.



TRAIN CONCOURSE

This waiting room measures 80 by 410 feet. Eight doors on either side of it afford access to stairways and ramps which lead to the station platforms. Wall bases are of marble, and all exposed metalwork is of aluminum. The flanking wall panels are occupied by mosaics illustrating many of Cincinnati's outstanding industries. The two central pictures on this and the facing page show figures taken from these decorations which lend interest and attractiveness to the two large concourses.

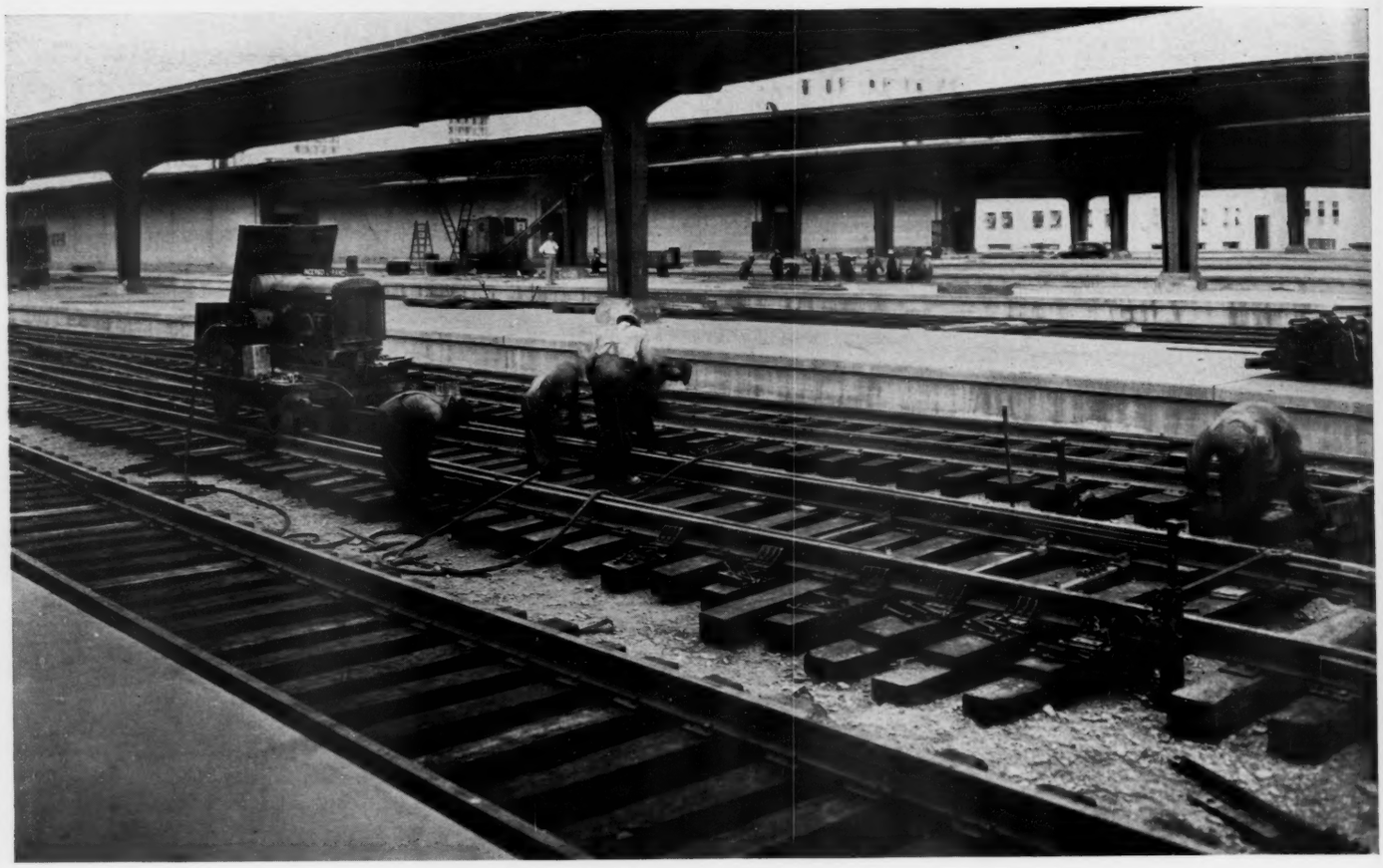
of from 30 to 35 tons. The types of piles differed with the ground conditions. Many of them were open-ended steel shells, ½ inch thick and 20 inches in diameter, that were driven with power hammers to depths ranging from 56 to 95 feet; then blown clean with compressed air; and filled with concrete. Manifestly, the preparation of the site was, in itself, a large and decidedly exacting undertaking.

The passenger station, which is the spectacular feature of the terminal, was designed by Fellheimer & Wagner, architects and engineers of New York City, who have specialized in this type of edifice. The station faces east, and fronts upon a landscaped park that is 1,400 feet long and about 500 feet wide. The park ascends gradually to a broad plaza at the entrance of the building. Because of the comparatively moderate size of the administrative organization, a towering structure was not necessary for office purposes. The primary requirement was an imposing facade that would give the station a dominating appearance. The architects accomplished this by crowning the facade with a roof forming half a dome having an internal span of 180 feet and rising to a height of 120 feet above the level of the plaza. This unique feature has demanded much engineering skill in its designing. The semi-circular facade is supported by two wings that contribute to a combined frontal expanse of 550 feet. The wings are virtually the housings of ramps that connect with platforms lying on a level below the main concourse at the station entrance. Separate ramps are used by street cars, buses, and taxicabs. The flow of this triple traffic is circulatory, and enters the station by the north wing and departs by the south one. Private cars arrive and leave by the plaza, swinging out of general traffic and rejoining it at points arranged for that purpose: people arriving or departing by public vehicles use the platforms linked by ramps with the main concourse floor.

The entrance concourse connects with a combined waiting room and train concourse, 410 feet long and 80 feet wide, which extends above and across the train platforms. Eight of these platforms are now in service and are flanked by fourteen tracks. Ultimately, there will be other platforms and a total of 22 tracks. The platforms and the train concourse can be reached either by ramps or stairways. The main concourse and the train concourse are decorated in a colorful and even spectacular fashion; and there are 23 large mosaic panels picturing, on a heroic scale, the development of the art of transportation and also symbolizing some of Cincinnati's famous industries. Indeed, the architects have appealed to the artistic sense at well-nigh every point within the building, and there is much to please the eye of the more or less hastening passenger as well as to absorb the attention and to instruct those who linger in the spacious waiting room. The train platforms average 21 feet wide and 1,600 feet long, and are pro-

BALD KNOB

This knoll was razed to supply material for filling in the terminal site.



LAYING NEW TRACK

Including the relocation of entering lines, 94 miles of track was laid in connection with the new terminal. The above view shows a portable tie-tamper air compressor, an indispensable machine in modern railroad construction. Such units furnish power for operating various pneumatic tools which not only speed up the work but also produce a safer and more substantial track than can be built with human labor alone.

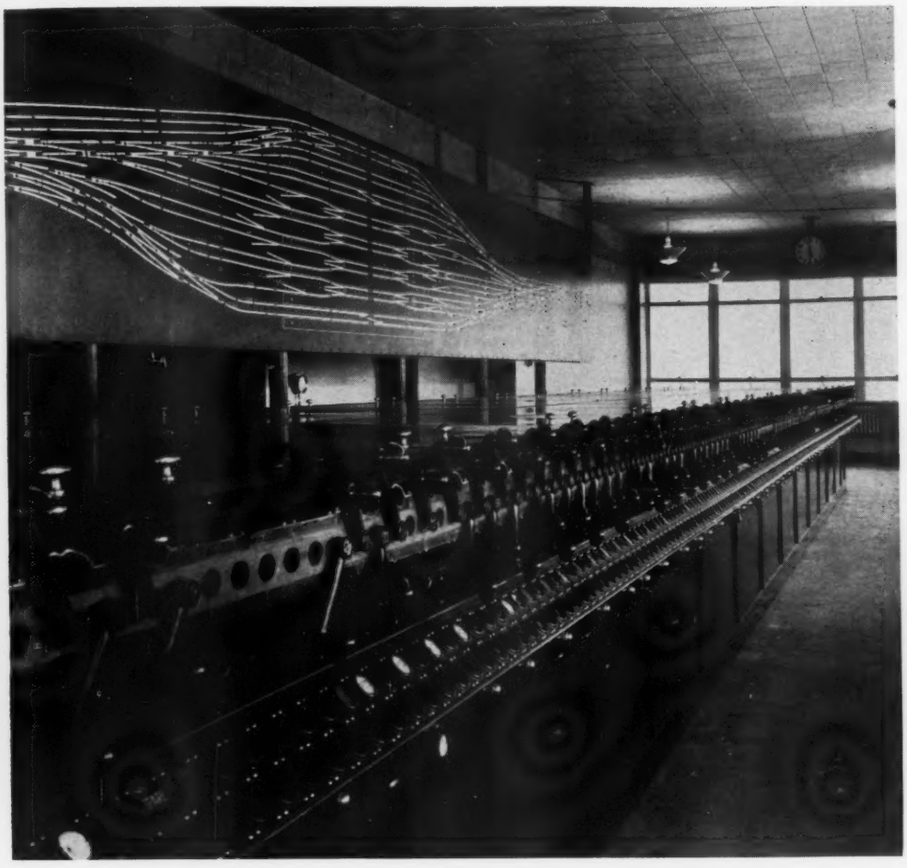
tected by canopy roofs of novel design.

The semidome roof of the main concourse is architecturally the most notable feature of the station, and it is decidedly different in design from any kindred steel structure. The semicircular arch of the facade is what is known as a barrel arch. Structurally it is not uncommon; but the problem was to combine it with a semidome that would be high enough to give the desired impressiveness and sufficiently expansive to roof over the large main concourse so as to insure a spacious effect aloft unmarred by visible bracing. The architects, therefore, decided to employ a succession of parallel, barrel-arch trusses that would divide the dome into a number of segments.

The base or spring line of the dome is about 90 feet above the floor of the main concourse, and the maximum external span of the dome is 202 feet—the corresponding span of the frontal barrel arch being 7 feet greater. Except for the front of the dome, which ties to the barrel arch, it was not possible to provide the support of abutments, and it was therefore necessary to give the main roof members the form of rigid trusses. In bridge building considerable structural deflection is permissible; but the same latitude was not allowed in the case of the steelwork of the dome. The members had to be made so stiff by the amount of steel used that, as the trusses reacted to their own dead weight, the maximum deflection would not exceed 4 inches in the case of the largest of the dome segments. The northern or right-hand end of each truss was secured at a fixed pin point, and the southern end was free to move slightly in that direction as the truss spread. This movement reached its utmost when the dome was completed and the roof finished. To accommodate the calculated horizontal displacement, each truss was fabricated a little short of its ultimate span, and the supporting column at the south end of each truss was set with a slight tilt northward—the column being gradually shoved into a perpendicular position as the truss adjusted itself. Permanent connections between these columns and the superposed trusses were not made until the final loads rested upon the steel structure of the dome. As can be seen, complicated and precise computations had to be made to insure the desired results. No movements have since taken place that have affected either the concrete or the stonework in contact with the steel.

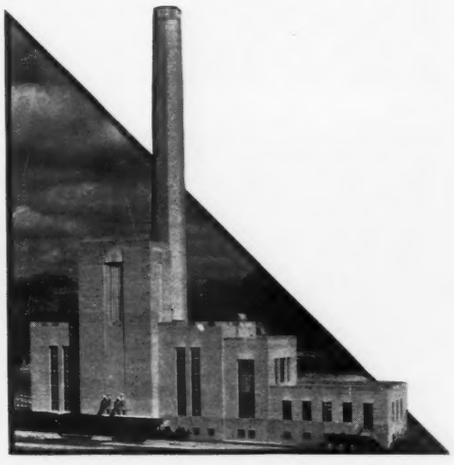
The framing of the dome was erected successively from back to front—that is, the shortest and the lightest members were put in place first. Portable steel towers, surmounted by jacks, were used to hold the trusses aloft during erection; and from two to five towers were employed, depending upon the size and weight of the particular truss. When assembled, the heaviest weighed 385 tons, and the largest contributive pieces weighed each approximately 35 tons. Each truss was fabricated in sections and assembled and reamed in the fabricator's yard prior to shipping to Cincinnati. In this way, accurate alignment of all rivet holes was assured. Special power-driven reamers were devised to do the work in the deep and heavy sections. Rivets 1¼ inches in diameter, with a grip of 7 inches, were used in the chord at the maximum crown section. The main columns that support the trusses are made of 14-inch H-beams with three 16x1-inch cover plates to each flange. The heavy steelwork was fabricated by The R. C. Mahon Company, Detroit, Mich. The steel was erected by the Bass Construction Company, also of Detroit, as subcontractor for James Stewart & Company, New York City.

Baggage discharged upon the passenger platforms from incoming trains is promptly removed by trucks, traveling on special ramps located beneath those that are used by passengers, and is thus delivered either on the lower-level vehicular platforms or to private cars at the front of the station. To avoid congestion on the passenger platforms, there have been provided independent mail and express facilities consisting in the main of an express building and a mail building. Each of these structures is fireproof and equipped with



SWITCH AND SIGNAL CONTROLS

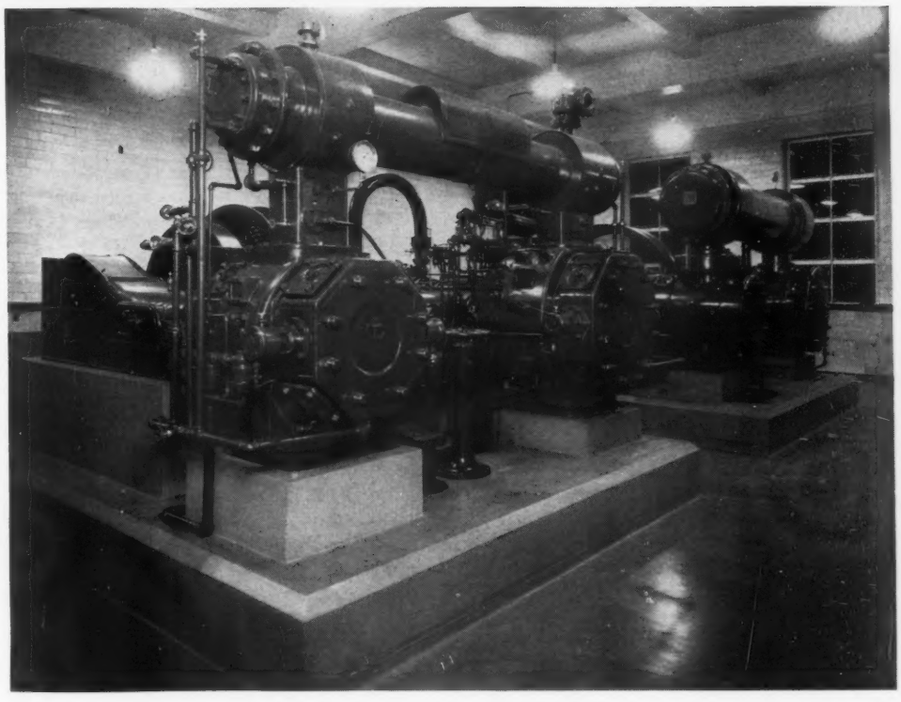
Switches and signals throughout the terminal are of the electro-pneumatic type and are controlled from the table shown at the left. It is equipped with 187 levers and has space for the addition of others up to 231. It is the largest of its type in service. Above it is an illuminated track model which shows all the main routes. Each of these is marked in letters 2 inches high. This room has been built to exclude virtually all noise.



mechanical facilities for the expeditious handling of postal and express matter.

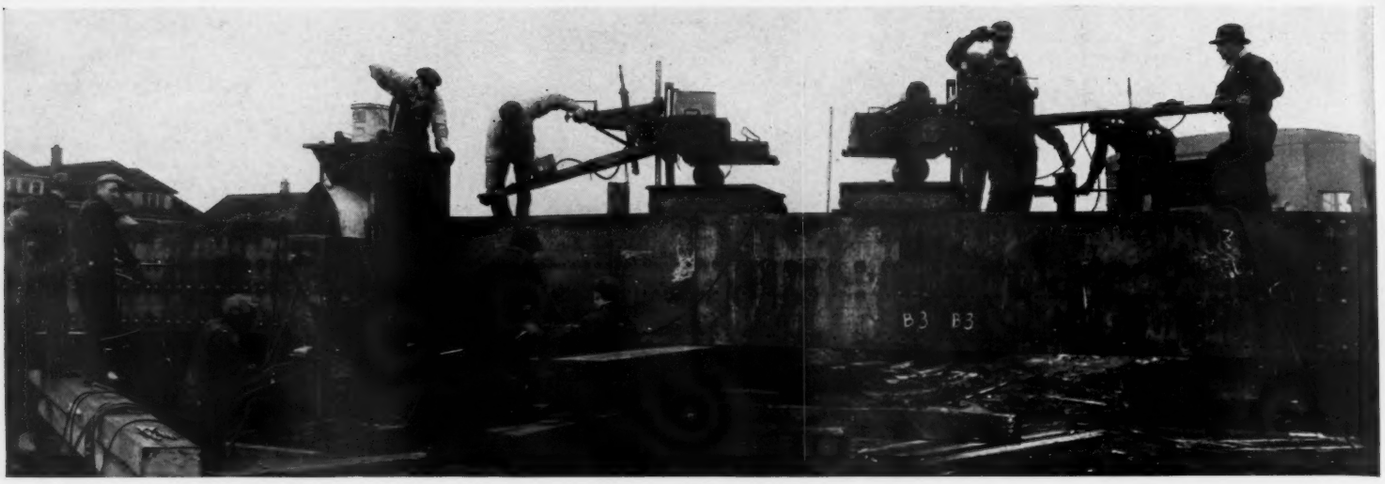
The terminal has a locomotive roundhouse with twenty inside stalls, and adjacent to it are seventeen outside tracks on which locomotives can be stored. The building is 130 feet wide from wall to wall and 340 feet long measured on the arc. An electrically operated twin-span turntable 115 feet long serves the roundhouse; and nearby are concrete washing platforms for cleaning locomotives. Fires are drawn from all locomotives in the roundhouse to reduce the smoke nuisance; and the locomotives are connected to a direct-steaming system that keeps them continually ready for service even when their fires are out. There are three 10-inch water cranes for locomotive feed, and the supply is drawn from a tank of 300,000 gallons capacity—the water being treated.

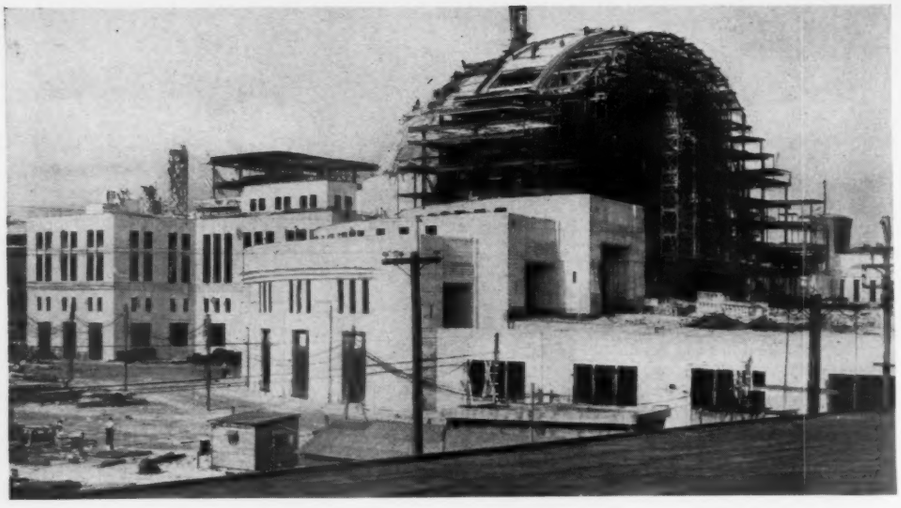
Steam for heating the terminal building and for other services called for the erection of a power house covering a ground area of 57½x215 feet. The boiler room contains three 10,000-hp. water-tube boilers carrying steam at 250 pounds pressure. In one section of this large building are wash-out tanks, a Zeolite water-treating plant, pumps, and compressors. There are two of the latter—a 2,200-cubic-foot XPV-3 steam-driven unit and a 1,721-cubic-foot PRE-2 electrically driven unit, both Ingersoll-Rand machines. The discharge pressure of each unit is 125 pounds. The steam machine operates on saturated steam of 225 pounds pressure at the throttle, and the electric machine is driven by 3-phase, 60-



COMPRESSED-AIR FACILITIES

Compressed air, piped to 194 outlets, is an important power medium around the new terminal. A partial list of its numerous uses appears in the text. The two compressors shown above have a combined piston displacement of more than 3,900 cubic feet per minute. One is electrically driven and the other is steam driven. These machines are installed in the power plant (small picture above) which is situated some distance from the passenger station and adjacent to the roundhouse and coach yard.





BUILDING THE SEMIDOME

The steel of the semidome in position (left) and concrete being poured on top of it. The concrete was applied at the same rate on the two sides to maintain an even distribution of weights at all times. Just below the near end of the arch are the three exit portals used by street cars, buses, and taxicabs. The upper picture shows one of the large chord members of the semidome. Workmen are reaming it with power tools devised especially for the purpose.

cycle current of 2,200 volts.

Compressed air is used at the terminal to open and close switches; to wash locomotives; to clean coaches, diners, and sleepers; to test brakes; to charge train lines; and to operate pneumatic tools in locomotive and car-repair work as well as pneumatic equipment provided for the maintenance of terminal trackage. As is usual where compressed air is available, other applications of this adaptable power medium will probably be made.

The coach yard has 27 tracks that have an average length of 1,500 feet; and while lying on those tracks the coaches, dining cars, and Pullmans are cleaned and reconditioned—much compressed air being utilized for these purposes. Associated with this yard there is a 3-story service building of reinforced concrete and brick in which are housed supplies and all facilities needed in the cleaning and the upkeep of the rolling stock.

The signal-and-interlocking system at the terminal is of the electro-pneumatic control type. The throat tracks north and south of the station are maneuvered from a single strategically located control room which commands a comprehensive view of the tracks in each direction. The layout of all switches and the position of each one are indicated on a model board with telltale lights. There are 187 levers on the signal table from which every switch can be moved—space being provided for 44 others to be added as needed. Switching operations at the north end are controlled from four signal cabins; and there are four signal bridges—two at the north throat, one at the south throat, and one at the southwest connection. In short, the signal layout, in its entirety, represents the latest accepted ideas in this field of railroad security.

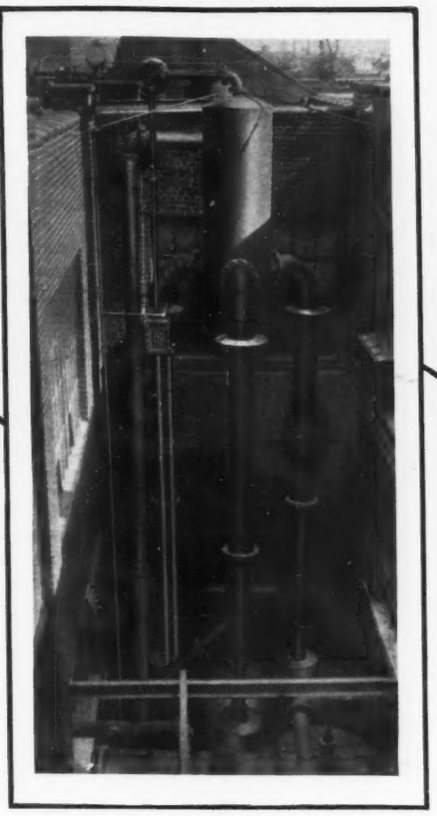
All told, the terminal, complete, has involved the placing of 223,400 cubic yards of concrete—not including paving, and has utilized 27,000 tons of steel in bridges and viaducts and 23,000 tons of steel in the station and the buildings mentioned. There are about 94 miles of trackage of which 45 miles have been laid during the relocation of lines for outlying approaches to the terminal. The main tracks are of 130-pound rails while 105-pound rails have been used for the side tracks. The ballast is washed gravel.

The two old stations were severely taxed in handling the maximum 24-hour passenger traffic of from 70 to 90 trains arriving and a like number departing. The new terminal has been designed to permit a combined 2-way movement of 216 trains daily, and thus to accommodate the arrival and the departure of approximately 17,000 passengers. The City of Cincinnati is constructing a new and broad boulevard reaching from the station plaza to the heart of the municipality.

The Cincinnati Union Terminal Company is owned by the following benefiting trunk lines: the Baltimore & Ohio Railroad, the Chesapeake & Ohio Railway, the New York Central Lines, the Pennsylvania Railroad, the Norfolk & Western Railway, the Southern Railway, and the Louisville & Nashville Railroad. Harry A. Worcester, vice-president of the New York Central System, is president, and George D. Crabbs of Cincinnati is vice-president.

The terminal project other than the station was planned and constructed by the engineering forces of the terminal company under the direction of Col. Henry M. Waite, chief engineer. The station building, with its approaches, was designed and constructed under the supervision of Alfred Fellheimer and Stewart Wagner. The other buildings were designed by Edgar D. Tyler, architect of the terminal company. The engineering organization was divided into departments: George P. Stowitts had charge of design until construction work began, when he assumed direction of all building; Pusey Jones had charge of design during the construction period—succeeding the late J. C. V. Christensen; Edison Brock served as mechanical engineer; and A. H. Sullivan was electrical engineer. The accounting department was headed by Earle Roberts; and contract and coördination was under E. W. Clark. At the peak of activities, the engineering staff numbered nearly 200 persons.

Compressing Steam to Make Cold Water



COLD-WATER PLANT

In this steam-jet refrigerating apparatus only steam and water are used to produce cold. The water, sprayed into the dome-topped receptacle at the bottom, boils at a low temperature because of the vacuum maintained within the vessel by the three steam jets which rise from its sides. It requires a great amount of heat to convert water into steam, and this heat is extracted from the water contained in the receptacle, thereby cooling it. The resultant vapor is immediately carried out and upward by the steam jets to a barometric condenser overhead. The vapor and the steam which removes it are there condensed. This unit, which has a capacity of 187½ tons of refrigeration a day, is installed in an Ohio rubber factory. The cold water which it produces is used to maintain the low temperature required during the preliminary mixing stage in the making of rubber.

C. H. VIVIAN

ACCUSTOMED though we are to the startling legerdemain of modern engineering achievement, nevertheless it may seem incongruous that steam can be made to produce cold. Yet, this is not only possible but entirely orthodox, and the process by which this is caused to be done has already been applied with success commercially. As a matter of fact, because of its simplicity, its safety, and its other advantages, this system is establishing itself prominently among the many means of refrigeration that are following in the wake of our recent wave of cold-consciousness.

The rise of air conditioning and of the countless applications of cooling as aids to industrial processes has placed a new emphasis on refrigeration. Because of this current interest, it may be well to recall to the reader's mind some of the underlying facts and principles that enter into the accepted methods of manufacturing cold. Having done that, we can then more easily explain the refrigerating process with which this article is primarily concerned.

To begin with, cold is defined as the comparative absence of heat or warmth. Cold is thus the negative or reverse of heat, but the two bear a definite relationship to each other. If we assume a circle, cold and heat may be said to occupy opposite points upon it. Thus, though widely separated, they are still in the same cycle. Actually, because refrigeration means subtracting heat, the engineering problems it involves are essentially those of heat engineering, and refrigeration thus becomes a branch of heat engineering. If we recognize this kinship of cold and heat and, at the same time, bear in mind that ice and steam are both forms of the same substance—water—we will then have no difficulty in understanding that cold water and steam differ not in material but only in kind.

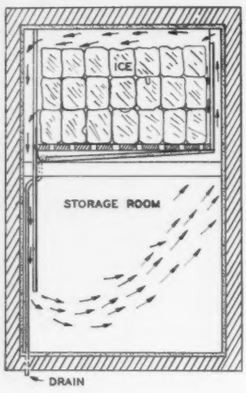
Cold is, of course, a relative condition. A temperature of 70° F. seems cool in July but warm in December. If we go from sea level to the mountains in summer we are cooled off; but the natives of the section may find the temperature uncomfortably warm. Similarly, to the Eskimo, spending a winter in the United States, our lowest temperature will be warm.

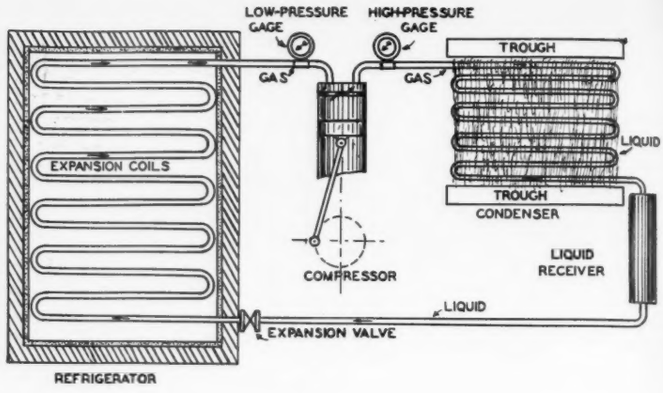
Refrigeration is the process of extracting some of the heat from whatever it is desired to make colder. We say "some of the heat" because, in ordinary practice, only a small proportion of the total warmth is removed. To extract all the heat from matter we should have to reduce it to absolute zero, which is —273°C., equivalent to —459.25° F. This has been approached closely in the laboratory, but never reached.

The most familiar form of refrigeration is, of course, that which is accomplished with ice. We place ice in the upper part of an inclosed box and provide air passages around it. The air that comes in contact with the ice gives up some of its heat. The ice surface is thereby warmed and melts—that is, it changes from a solid to a liquid state. In melting, each pound of ice absorbs 144 Btu's of heat—a Btu., or British thermal unit, being the amount of heat required to raise the temperature of 1 pound of water 1°F. As the air is cooled it descends and is replaced by warm air rising from below. By repetition of this process, termed convection, circulation of air within the box is set up. During this circulation the cool air absorbs heat units from the food or other articles in the box. All the heat is eventually consumed in melting the ice.

As ice melts at 32°F. it is apparent that no temperature below that point can be obtained by means of ice alone. To secure temperatures lower than 32° it is necessary to use some other process of refrigeration. This is what is done in the case of the mechanical household refrigerator and, in fact, in the manufacture of artificial ice itself, as well as in various other forms of refrigeration. The refrigerant commonly employed in America for this work is ammonia. Formerly it was used almost exclusively, but in recent years carbon dioxide, sulphur dioxide, and various specially compounded chemicals have been employed. However, as the nature of the process is the same regardless of the refrigerant, we may for purposes of illustration consider what happens when ammonia is made to produce cold.

All of us have experienced the sensation of cold that results from evaporation of a liquid. If we put a drop of ether or some other highly volatile liquid upon the back of our hand, we are immediately conscious of it because the





TWO COOLING METHODS

At the left is a cross section of an ice bunker which shows how air is cooled by contact with the ice, descends because of its increased density, is warmed by extracting heat from the contents of the storage compartment, and then rises to begin another cycle. The ammonia-refrigeration cycle is illustrated at the right. Liquid ammonia is allowed to pass through the expansion, or reducing, valve into coils. There, because of the reduced pressure, it boils and forms gas. In changing form, it takes up heat and thereby exerts its cooling effect. The gas passes on to a compressor, where its pressure is raised. To extract the absorbed heat and heat of compression it is directed through coils over which water runs. Thus cooled, the gas liquefies.

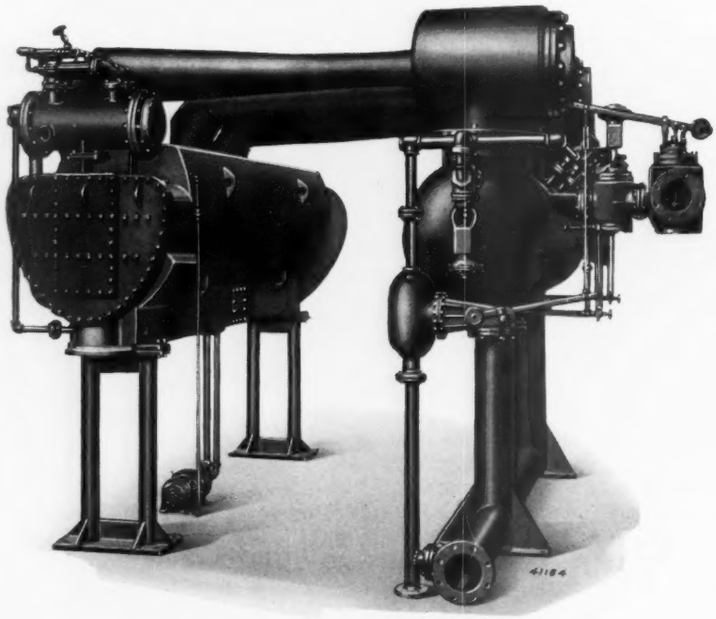
spot feels cold. The same feeling is induced if we bathe a portion of our body with alcohol; and advantage is taken of this fact to cool the skin of a feverish person in the sick room. Why does this evaporation have a cooling effect? The answer is found by examining what takes place when a liquid is transformed into a vapor. We noted previously that it requires 144 Btu's of heat to transform 1 pound of ice at 32° F. to 1 pound of water, even though there is no change in the temperature. This is known as the heat of fusion. Similarly, a considerable amount of heat, which varies with different liquids, is required to transform the liquid into vapor. This is termed the latent heat of evaporation. In the case of ether, the heat of evaporation is 162, which means that in changing its form from a liquid to a vapor a pound of ether takes up 162 Btu's. In the previously cited example of placing a drop of ether on the hand, some of these heat units will be extracted from the skin, and it is this that creates the sensation of cold.

Ammonia at ordinary temperatures and pressures is a gas. Upon being compressed it becomes liquid, and it is this liquid that is used as a starting point in ammonia refrigeration. A quantity of ammonia under pressure is allowed to escape gradually into a coil of pipe in which the pressure is at or close to normal. The ammonia boils when it is transformed from a liquid into a vapor. The latent heat of evaporation of ammonia at average temperature is around 612. That is to say, during the process of evaporation each pound of ammonia absorbs 612 Btu's of heat. Obviously, this heat must come from somewhere, and as it cannot be obtained from within the pipe coil, itself, it is extracted from the air surrounding the coil. It is this that cools the atmosphere of the room in which the evaporating or refrigerating process takes place.

The ammonia vapor passes on through the coil into a compressor. There it is compressed sufficiently to convert it back into liquid form; but, as it has taken up heat during vaporization and as work, which also appears as heat, has been done upon it during compression, it will not liquefy until it is cooled. After compression, therefore, it is passed through a condenser, where it is cooled sufficiently by running water over the pipes which inclose it to cause it to condense. The liquid ammonia then returns to the starting point, and is ready for use again. We observe then, that the ammonia exerts its cooling effect because it absorbs heat and that to refit it for this work it is necessary to extract that heat from it. Regardless of the refrigerant used, the action is the same, although the cooling capacity will vary with the inherent characteristics of the substance, as will the mechanical requirements such as compression, etc.

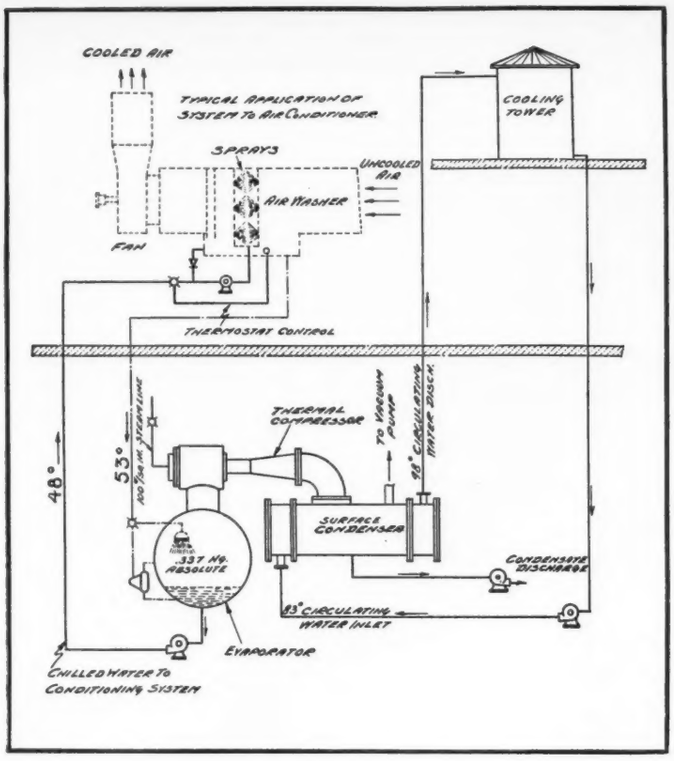
By using suitable refrigerants it is possible to obtain temperatures far below the freezing point of water. Ammonia, for example, boils at —28.2°F. under normal atmospheric pressure. As there is a definite relationship between pressure and temperature, the ammonia can, by the application of pressure, be kept from boiling at ordinary temperatures, which is the reason for having it under pressure at the beginning of the refrigerating cycle. Liquid carbon dioxide boils at —70.8°, and liquid hydrogen at —422.5°. It is easy to see, then, that by choosing suitable refrigerants and by controlling pressures and temperatures under which the refrigerating cycle is allowed to take place it is possible to secure any one of a wide range of low temperatures. This will, however, involve the expenditure of different amounts of mechanical work—in general, the lower the boiling point of a liquid the greater the pressure required to liquefy it again after it has been allowed to vaporize. This calls for the use not only of more power to drive the compressor but also of heavier materials to withstand the higher pressures involved. For ordinary refrigerating work, such as the manufacture of ice, cold storage, etc., ammonia produces sufficiently low temperatures; and as its characteristics are such that it requires handling at maximum pressures corresponding closely to those used in ordinary steam engineering, it is only natural that this compound should have been widely adopted for this field of work.

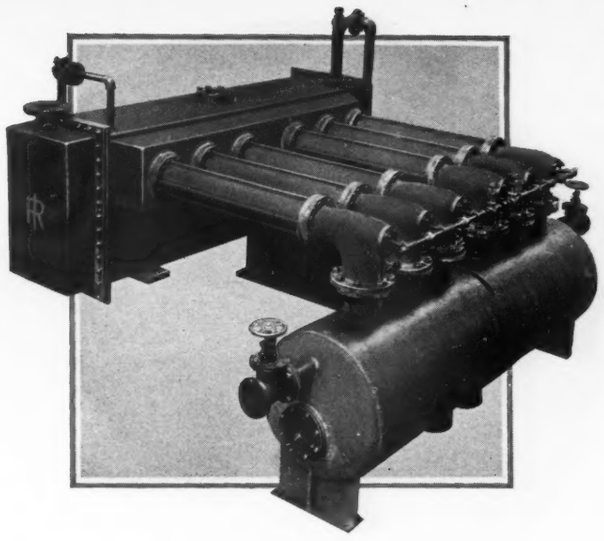
Because of its pungent odor and its distressing and damaging effect upon the human organism, ammonia is not in favor for service where it might be breathed by people in case



FOR AIR CONDITIONING

The steam-jet refrigerating unit shown here produces cold water for conditioning the air in an office building. Since it requires only water, this type of equipment is absolutely safe in case of leakage and can be used without hazard in hotels, theaters and like places where many people congregate. It requires no heavy foundations, and can be set up on any floor of a building or placed in old structures whose upper floors will not sustain heavy loads.





STEAM-REFRIGERATION CYCLE

The diagram illustrates the operation of the thermal-compressor refrigeration system. The chilled water, here being used for air conditioning, is returned to the evaporator after performing its work—its temperature having been raised about 5 degrees during the circuit. The cooling tower may or may not be required, depending upon the available supply of condenser cooling water. The view above is of a typical thermal-compressor refrigerating unit. Evaporation and cooling take place in the cylinder at the right. Six steam jets rise from it and lead to the condenser at the left. There are six compartments in the evaporator, each with its own jet. This permits shutting down one or more jets without affecting the others.

it should escape. Because of these disadvantages, cooling by ammonia is nearly always done indirectly. The cooling coils are so arranged that they transfer cold to water or to air, which is then circulated. This transfer involves a loss of approximately 10°F., so that to secure water at 40° it is necessary to create a temperature of around 30° in the ammonia coils.

The rise of mechanical household refrigerators and of air-conditioning systems has led to the development of several refrigerants which can be used safely, without endangering human beings or subjecting them to discomfort in case of leakage. Some of these refrigerants have such characteristics that the whole cycle of refrigeration is carried on at pressures below normal atmospheric pressure. Makers of equipment using these materials feature the fact that there can be no escape of the refrigerant, despite a leak, because there is no internal pressure.

Having sketched briefly some of the elements of refrigeration, we shall now return to a consideration of that form of cooling which makes use of water only. That water has an efficient cycle of refrigeration has been known for a great many years, but until recently it was not believed suitable for commercial application. However, there has been developed a system known as steam-jet refrigeration which is not only suitable for air conditioning and for many industrial operations requiring cooling but which will, under certain conditions, also be more economical and more satisfactory than any other system of refrigeration.

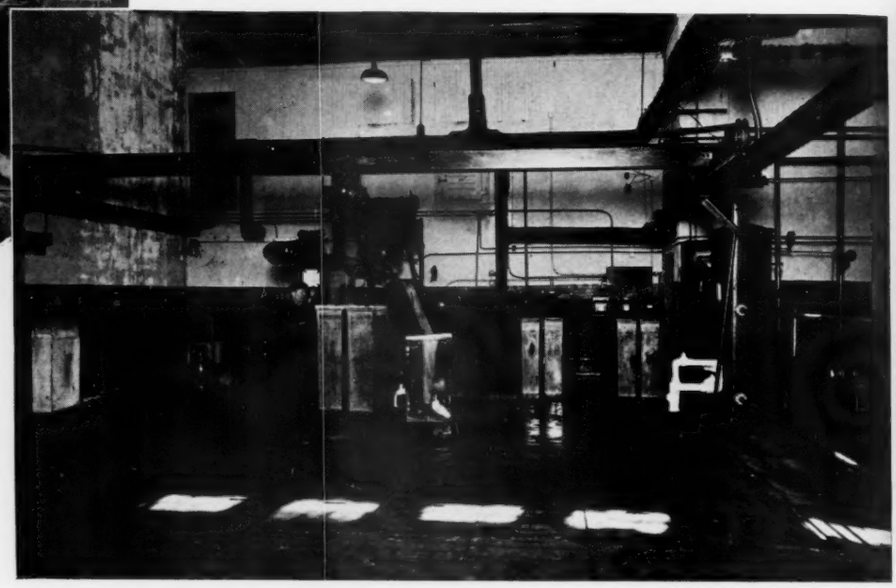
It may be difficult to understand how cold can be produced with water alone, but references to our previous explanation of the ammonia cycle will help to clarify this. We know that the boiling point of water, which is 212°F. at sea level, grows steadily less as we rise in elevation. Anyone who has driven an automobile over the high mountain passes of the western part of the country has noticed how much easier the radiator water boiled with increasing altitude.

By artificially reducing the pressure on water, it is possible to make it boil at a point much below normal temperature, and this is what is actually done in the steam-jet refrigerator. If we exhaust the air from a vessel of water until the pressure is only .085 pound per square inch, instead of the normal atmospheric pressure of 14.7 pounds per square inch, we can cause the water to boil at 32°. In other words, the temperature which is the freezing point of water ordinarily will now become its boiling point. By exhausting the air to a still greater degree it is possible to boil water even below 32°.

The steam-jet refrigerator takes advantage of this principle. The refrigerating chamber is an airtight metal receptacle about one-fifth of which is filled with water. The space above the water is evacuated until the pressure is less than 1 inch of mercury per square inch as compared with the normal barometric pressure of 30 inches of mercury. This evacuation is accomplished with a steam-jet type of vacuum pump. In this machine, steam rushing past an opening in the receptacle at a velocity of from 3,500 to 4,500 feet per second withdraws air from it in the same manner that a person can withdraw air from a bottle by holding the open top up to his lips and blowing across it.

Within the top of the receptacle is a horizontal pipe through which water is introduced and allowed to escape in small quantities in the form of one or more sprays. Because the boiling point of water has been reduced by the vacuum, these sprays immediately flash into vapor. The water actually boils, just as the ammonia boiled in the example previously mentioned. As the latent heat of evaporation of water at this reduced pressure is about 1,060, the transformation into vapor of each pound of water requires 1,060 Btu's of heat. As there is no other source from which to obtain this heat than the water in the bottom of the receptacle, it is abstracted therefrom with the result that that water is cooled proportionately. The vapor is immediately withdrawn by the steam jet and carried along with the steam into a condenser. *En route* it passes through the relatively narrow throat of the jet, which serves to compress it. Thus, the steam jet acts as did the compressor in the case of ammonia refrigeration—in fact, it is known as a thermal compressor. The condenser is an ordinary steam condenser, either of a barometric or surface type, wherein water is used as the condensing medium. A vacuum lower than that in the flash chamber is maintained in the condenser.

As the water in the receptacle becomes chilled to a certain desired temperature it is withdrawn and pumped to the point of use. If it is to be employed for air conditioning it may be sprayed through a current of air, which is thereby cooled and humidified at the same time. If it is to be utilized for other cooling work it is piped to equipment of a suitable nature. The cycle is a continuous one—chilled water being returned to the evaporating receptacle after it has served its



MANUFACTURING ICE

In making ice, large cans are filled with water and set in the floor of a room (below) where low-temperature brine is circulated around them in pipes. The resulting cakes, weighing as much as 300 pounds each, are stored in compartments like that at the left. The temperature is maintained below the freezing point of water by brine circulating in pipes overhead.

purpose. Ordinarily it is heated only a few degrees during the circulation and is, therefore, relatively easy to cool again to the desired point.

While all the elements in such an apparatus are important, the vital member is the steam jet. Upon its design will depend not only the amount of cooling that will be obtained but also, to a great degree, the efficiency with which it will be accomplished. Since the quantity of steam required per unit of refrigeration will vary widely according to the pressure at which it is used, it is essential that a jet be designed so as to utilize the available steam with the greatest possible efficiency. It calls for extensive experimentation on the part of the manufacturer to ascertain the proportions, sizes, and arrangements of essential parts that will give the best possible performance as regards capacity and compression range per pound of steam used.

The amount of cold produced by refrigerating machines of this and other types is measured in terms of tons of refrigeration. This is something distinct from a ton of ice. A ton of refrigeration represents the removal of the quantity of heat which is required to change 1 ton of ice at 32°F. to water at the same temperature in 24 hours. In other words, it means the abstraction of the heat of fusion from one ton of ice. Actually, the heat whose removal is involved totals 288,000 Btu's. For ordinary purposes a ton of refrigeration means the removal of 12,000 Btu's per hour or 200 Btu's per minute.

An accompanying diagram shows a steam-jet refrigerating unit of the type now being manufactured by Ingersoll-Rand Company. It will be noticed that, in the example illustrated, chilled water is serving to condition air. Water is discharged from the evaporator at a temperature of 48°F. and picks up enough heat units during circulation to increase its temperature 5°, or to 53° upon its return to the evaporator. The diagram shows a cooling tower through which is passed the water used in the condenser. This is the usual arrangement, except where a plentiful supply of water is available at low cost.

The type of condenser employed varies with the conditions. The use of a barometric condenser requires a location that can accommodate a drainage pipe or leg 35 feet high. Three pumps are necessary with the average installation of this kind: one for the chilled water, one for the discharge from the condenser, and one for the condenser circulating water.

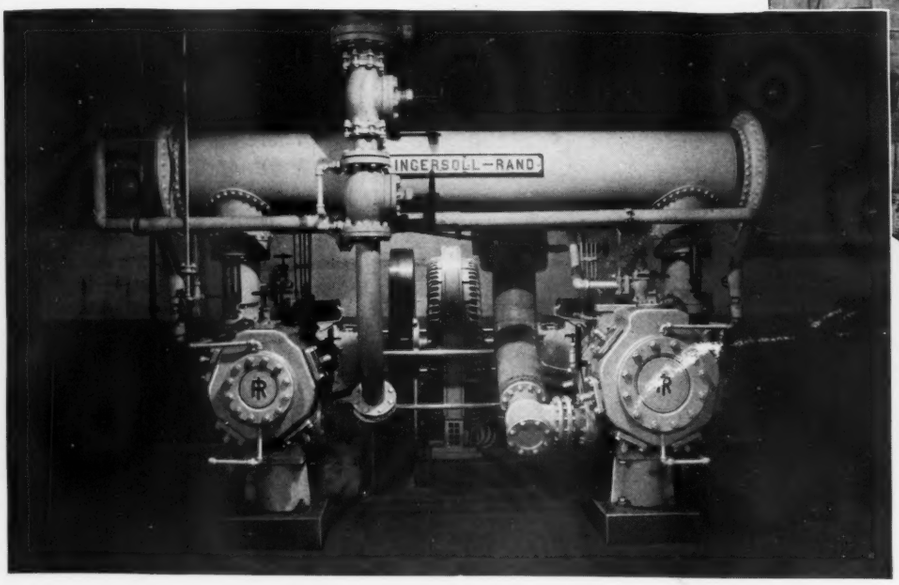
The exact place the steam-jet refrigerator will occupy in air conditioning and in industrial cooling remains for the future to establish. It has a number of advantages, as compared with other refrigerating systems, and there are many places where it will be found to be the most satisfactory and the least expensive type of equipment obtainable. Its first cost is generally lower than that of other systems when facilities exist for providing the necessary steam. The operating costs also are usually less, although the relative prices of steam, electricity, and cooling water will have a bearing upon them. Steam-jet refrigerators are easy to install, simple to operate, and, frequently, will save the cost of skilled supervision which is required with some other systems. This type of unit will also operate at low maintenance cost because there are no moving parts except the pumps, which are necessary in any system. For the same reason there is less chance of failure or enforced shutdown, and a long life of service may be expected. There is no vibration and no noise. The equipment can be installed without heavy foundations and is adaptable for use in old buildings which are not capable of carrying heavy weights. It can be set up on any floor of a building and need not be confined to the basement, as is the case with some other systems.

One paramount advantage of this unit is its absolute safety. There is no gas nor other objectionable substance to escape in case something goes wrong. For this reason steam-jet refrigeration can be installed in theaters, hotels, or the like, where large groups of people congregate, without the fear of subjecting them to possible danger; and can be placed on the upper floors of such structures if conditions make this desirable.

There is also the advantage of reserve capacity. A unit which will chill 100 gallons per minute from 45° to 40° F. will chill 125 gallons per minute from 50° to 45°. In other words, its cooling capacity can be increased 25 per cent if the final temperature of the chilled water is only 5° higher. This increase in capacity is far greater than that of other types of equipment under the same conditions. The steam-jet refrigerator will operate under any one of a wide range of steam conditions. The cost will be lower with steam at or above 100 pounds pressure than with low-pressure steam, but steam at pressures as low as 10 to 15 pounds can be satisfactorily used. In such

AMMONIA COMPRESSOR

Although their cylinders and certain other parts are of special make, ammonia compressors are, in general, similar to air compressors. The machine shown below is a 2-stage, electrically driven unit and is one of three of its kind installed in the cold-storage plant of a large railroad terminal. At the right is shown produce stacked high in one of the cooled rooms.



cases the steam consumption per ton of refrigeration increases, as does the amount of cooling water required, and it may be necessary to install a larger condenser and thermal compressor, and, consequently, to augment the first cost. It may also become necessary to provide a special type of ejector to remove air from the condenser.

Equipment of this type is flexible, and, by increasing the number of thermal compressors and by adding correspondingly to the size of the other elements in the system, it is possible to build units of relatively large size. Equipment having a capacity of nearly 200 tons of refrigeration has been installed, and larger units can be built readily if required.

The field of usefulness of this type of refrigeration is a wide one. It is suitable not only for general air conditioning, of which we shall cite a specific instance, but also for various special industrial applications where it is desired to utilize cooling in some step of the manufacturing process. Likewise the equipment is suitable for general refrigerating work where extremely low temperatures are not required. It should be noted, however, that in this case the refrigerant itself, which is the water, can be circulated and that there is, therefore, no transfer loss like that sustained when the cooling effect, produced by ammonia or some other refrigerant, must in turn be communicated to water for circulation.

The owners of a large office building recently rented several floors to one tenant under a lease which provided that the space was to be air conditioned. Steam-jet refrigeration was determined upon as being the most satisfactory cooling equipment for this purpose. Accordingly, there was installed an Ingersoll-Rand unit with thermal compressors having a capacity of 180 tons of refrigeration when cooling water to 52°F., and with a condenser and evaporator capacity sufficient to permit the addition of another thermal compressor to raise the capacity of the unit to 250 tons. The condenser water is cooled in a reversed air-washer type of cooling tower located in the basement; and a connection is also made with the city water distribution system to provide supplemental condenser cooling water.

One of the several industrial applications of steam-jet refrigeration is that of cooling cargo spaces of steam vessels used for transporting bananas from Central America to ports in the United States. A manufacturer of dry ice near New York City is using equipment of this kind in connection with his work. In making dry ice, carbon-dioxide gas is compressed and then allowed suddenly to expand, thereby exerting a refrigerating effect similar to that which has been outlined. If the compression takes place at ordinary temperatures, a pressure of 1,250 pounds to the square inch is required to liquefy the gas. By reducing the temperature the pressure also can be reduced. The plant in question had considerable surplus steam at 200 pounds pressure. This is being put to use in an Ingersoll-Rand steam-jet refrigerating unit which serves to lower the temperature of the gas to 47°F. At this temperature the gas will liquefy at 640 pounds pressure. This refrigerating equipment is, therefore, reducing the pressure of compression 610 pounds and is saving the cost of the power which it represents. The unit has a capacity of 108 tons of refrigeration with 45° water. Condensers having a capacity equivalent to 154 tons of refrigeration have been installed; and the output can be increased to that figure by adding another steam jet.

In the plant of the Mohawk Rubber Company at Akron, Ohio, an Ingersoll-Rand steam-jet refrigerator does the cooling which materially assists in one stage of the manufacturing process. For the facts contained in the following discussion of this installation we are indebted to R. R. Jones of Akron, Ohio. Mr. Jones is a consulting engineer who specializes in rubber-industry work; and it was under his direction that the equipment referred to was installed.

In the manufacture of rubber, sulphur is added during the preliminary mixing stage to effect the essential process of curing. To accelerate the combination of the sulphur with the rubber compounds, certain chemicals are mixed with the latter. It is necessary that all mixing apparatus be kept cool in order that the stock remain below a certain critical temperature. The use of these chemicals under controlled-temperature conditions reduces the final processing time of the product to as little as one-quarter of that formerly required and increases the plant capacity proportionately. During the summer months it is impossible to secure surface water cold enough for the purpose, and, as a result, numerous wells have been drilled where the subsurface is water bearing. Where water from the ground is not obtainable, refrigerating systems have been set up, and these are often of large capacity. Because of its lower cost, surface water is used

MANUFACTURED WEATHER

Approximately 200 industries now make use of air conditioning either to aid process work or to enhance the comfort of workers. The view at the right shows the interior of a macaroni factory where operations are conducted in a controlled atmosphere. The room has walls composed mostly of glass, and is as clean as any housewife's kitchen. The macaroni is formed by the machines at the left which force it, under hydraulic pressure, through perforations. It is cut off in suitable lengths and hung on the frames to dry.

AIR-CONDITIONED CAR

Interior of a parlor coach on the Baltimore & Ohio Railroad, which was the first among the rail carriers to condition the air on trains. The grilles near the ceiling provide for the admission of cooled and washed air. Windows are kept closed, and dirt and smoke, which were formerly considered necessary accompaniments to summertime train travel, are almost eliminated.

Ewing Galloway Photo.

during those months of the year when it is cool enough to answer the requirements.

Since the fixed charges on the refrigerating plant continue even though the system is not operating, it is highly desirable in the interest of a low, over-all annual water cost that the refrigerating equipment be of a type which has a low first cost as well as a low operating cost. Rubber-plant engineers strive to secure machines which will compare favorably with a driven well in first cost and which can be operated and maintained for less than wells of equivalent capacity. Refrigerating machines of the conventional type do not meet these *desiderata*, but steam-jet refrigerating systems do.

The steam-jet refrigerating unit installed at the Mohawk Rubber Company plant has a capacity of 187½ tons, which is to say that it will remove 546,000,000 Btu's of heat in a 24-hour period. Three steam jets are used to secure the high vacuum required for the evaporating chamber, and a high-level jet-type condenser is installed. Any type of condenser would have answered the purpose, but the form selected best met the conditions in this case. Operating water for the condenser is obtained from a small stream during those portions of the year when the temperature is low enough to provide an efficient intercondenser vacuum. The high-level jet is served by small jet-type air ejectors, which is usual practice.

The chilled water is circulated through the mixing machines and then returns by gravity to a sump, from which it is drawn by the refrigerating plant to begin another cycle. In this installation the only moving parts are two pumps—the condenser ejection pump and the chilled-water pump. If the stream had not been available as a source of condenser cooling water, a cooling tower or pond would have been provided, in which case a third pump would have been required.

This refrigerating plant was designed for steam at around 140 pounds gauge pressure, but steam at lower pressures will be used when available at some future time. In commenting upon this installation, Mr. Jones says: "Most industrial plants have some exhaust steam available from engines or from process work, and in winter this is usually sufficient for heating the buildings and ordinarily is so applied. In the summertime, however, it is wasted, and it seems reasonable to assume that future developments will make it possible to use this waste steam for the purpose of cooling water during the season when cool water is needed. Even where waste steam is not available the operating cost of this type of apparatus is low, as it consists of only the cost of the coal necessary to produce the additional steam required. The fixed charges are low because of the low first cost of the equipment, and maintenance charges cannot help being low because of the character of the equipment. The pumps may be left out of consideration, as there will be need for these in any event. For example, a cold-water pump in the Mohawk Rubber Company installation serves to pump water direct from the creek during times when the temperature of this water is low enough to permit its use for cooling. In many instances the cost of operating a refrigerating unit of this kind will be less than the cost of pumping water from wells.

"The facts just outlined, together with the controllable features of the steam-jet refrigerator, formed the basis for selecting this type of equipment for the Mohawk Rubber Company. While it was selected to meet conditions in one particular industry, it will be evident that the reasons for its choice will apply to many other industries. In any consideration of the steam-jet refrigerator it should be remembered that it can be used to cool other things than water. Therefore, the range of its service is a wide one."

One of the refrigeration and air-conditioning trade publications recently commented editorially that "one of the cheering things in cooling work is the development of the steam-jet refrigeration machine which will operate on steam pressures as low as 10 pounds, can be run off of ordinary low-pressure steam boilers, and has no moving parts." The opinion was then expressed that, because of its low first cost and low operating expense, this type of apparatus "seems to open up a big field for refrigeration plants that was previously closed to them."

VENUS AND ROME

were worshipped in the temple that stood on this site. It was designed by Emperor Hadrian in 135 B. C., and was the largest of its kind ever built in the city. The whole area was subsequently used as a quarry, and all that remains of the edifice are ruins of a fountain and of two cellae, one of which is pictured above with the modern church of Santa Francesca Romana in the background.

ROME'S NEW ROADS

The Via del Mare (above) with the Tarpeian Rock on the left and the Theater of Marcellus in the distance. By the building of this short thoroughfare the center of Rome has been put within easy motoring reach of the popular seaside resort of Ostia on the Thyrrhenian Sea. The road is 100 feet wide. The lower end of the Via dell' Impero (left) as seen from one of the arches of the Colosseum.

A New Rome in an Old Setting

A. M. HOFFMANN

ROADBUILDING and, incidentally, archaeology, are outstanding features of a far-reaching program of city planning that is now well underway in Rome, which, according to the pronouncement of Premier Benito Mussolini, "must become a marvel to all the peoples of the world, great, ordered, and powerful as in the days of the first empire under Augustus." With these words the premier accepted, on October 28, 1931, the 5-year plan of city expansion and betterment that had been drawn up by a special commission appointed by him on April 14, 1931. That commission was given six months within which to complete its task; and it is to the credit of its members that, with but minor modifications, the plan was accepted as formulated.

Rome, on its seven hills, has increased measurably in population since it became the imperial capital in 1871; and, in order to appreciate what is taking place there today, it might be well briefly to go back to that period. It was not long after Rome had been proclaimed the seat of government that it was found necessary to extend the city limits. That sufficed for a while; but by 1908 there were 531,313 people within its confines, more than could be adequately accommodated. A year later, the authorities set about to ameliorate conditions; but the plan then adopted was never fully carried out for various reasons, chiefly on account of the World War. This 1909 plan was revised subsequently; and, although approved, was never acted upon. Some of its ideas, however, have been embodied in the 1931 program of improvement and development that is now materially changing the physiognomy of the city.

In the meantime the population multiplied, and on December 31, 1931, the date of the last census, numbered 1,019,248. It was with these facts in mind that the commission drew up a plan that would provide not only for the needs of today but for those of many decades to come, that would make of Rome one of the most imposing capitals in Europe, with ample room for its citizenry and with splendid thoroughfares that would relieve traffic congestion within its own gates and adequately take care of the through traffic which is becoming increasingly heavy as a result of the numerous "autostrade"—speedways—built by the Fascist government since the organization three years ago of the Azienda Autonoma Slatale della Strada. This organization has charge of the maintenance and construction of roads.

It is the latter phase of the present project that concerns us now; and of immediate interest are the two fine highways which were completed on October 28, 1932. They are in the heart of the Eternal City, in ancient and historic Rome, and are therefore of more than national importance. Both take off from the Piazza Venezia, one leading southwest to the sea and the other southeast to the hills. It is of the last-mentioned, especially, that the Italians are justly proud, of the Via dell'Impero—the Way of the Empire. It traces its course through the ruins of the five great imperial forums—survivals of the days when the Roman Empire was at its height—which were built, respectively, by Augustus, Julius Caesar, Vespasian, Nerva, and Trajan. The road is, therefore, most appropriately named, for it is truly the way of the empire. At one end of it, free of all impeding structures, stands the imposing Colosseum or Flavian Amphitheater, which dates back to 80 A.D., and at the other is the equally imposing monument of Victor Emmanuel II—landmarks of eras nearly 2,000 years apart. Between those two points the Via dell'Impero stretches for a length of approximately 2,295

BEFORE AND AFTER

Section of so-called ancient Rome (below) that has been transformed by the building of the Via dell'Impero. From Caesar's Forum in the foreground, shown in the process of being unearthed, to the Colosseum in the background was cleared a path 100 feet wide and nearly 3,000 feet long. Few of the houses seen in this picture remain standing. The same area (right) taken from a slightly different angle and as it appeared from the Piazza Venezia shortly after the Way of the Empire was opened to traffic. Part of Caesar's Forum is visible in the extreme right-hand corner.

Acme Photo.

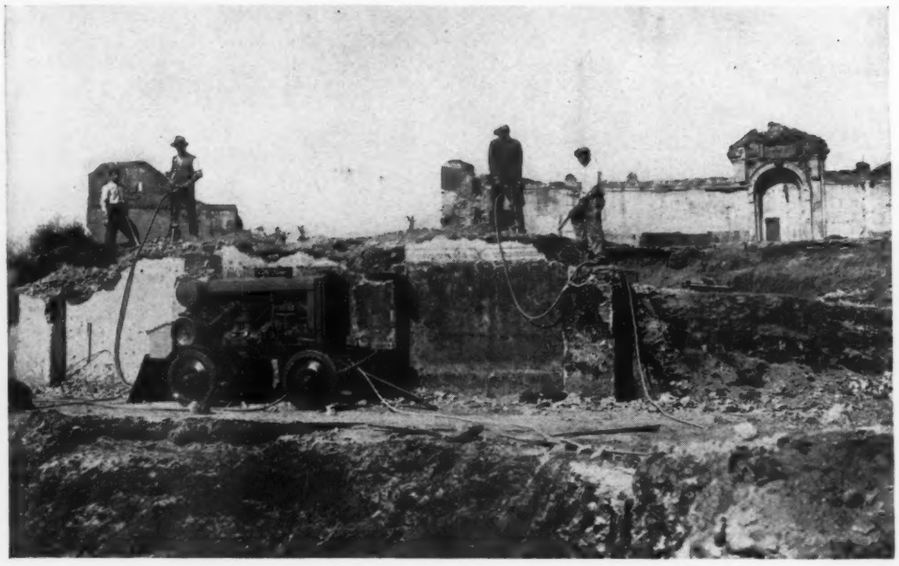
feet; and it is perhaps no exaggeration to say that it would be impossible anywhere within so short a span to find so much of outstanding archaeological and historical interest. As a matter of fact, the architectural plan of the avenue is generally conceded to be a brilliant one. The boulevard is nearly 100 feet wide, and its two traffic lanes are separated by broad strips or islands attractively landscaped. Cypress trees flank both sides of the street; and the various forums are being turned into veritable garden spots.

Starting at the Piazza Venezia, which is the topographical center of the city, and walking down the right side of the Way of the Empire, we pass the Vittoriano, the symbol of new Italy; the Arch of Septimius Severus; and the Forum of Caesar. Next we come to the Roman Forum with its wealth of reminders of a great and glorious past. There we find the Curia in front of which was the platform from which the Roman senators addressed the people many centuries ago; the lovely white-marble Temple of Vesta which has been built on the spot where the original stood; and the Basilica of Constantine through which can be caught glimpses of the Farnese Gardens on the Palatine where, legend has it, Romulus founded the settlement that has since become Rome. Leaving behind us the modern church of Santa Francesca Romana, which occupies part of the site of the Temple of Venus and Rome, we reach the Colosseum and the Arch of Constantine, which frames the tree-lined Via di San Gregorio. This arch, erected 312 A.D., is in a splendid state of preservation.

Taking the opposite side of the Via dell' Impero, with the Piazza Venezia again our starting point, we see the Forum of Trajan with its famous column and semicircular market buildings. The latter, it should be said, have been uncovered but lately, and are in such excellent condition that the booths are now used on special occasions for the sale of books and flowers. A little farther along there is the Palazzetto and Loggia of the Knights of Rhodes, followed by the forums of Augustus and Nerva. Space does not permit the recounting here of all the historic monuments and edifices that face this new and popular thoroughfare, but enough have been mentioned to make it plain to the reader that by its building the Italian government has literally resurrected ancient Rome.

Again we are back at the Colosseum, and it is difficult for us to conceive that not so long ago the site of the broad, fine highway was one of the most thickly populated sections of the Eternal City. Work on the project was begun in December, 1931, and the road was opened to traffic late in October the year following. During the intervening months it was necessary, first, to raze whole blocks of houses; next, to tear up numerous little streets; and, finally, to clear away an obstruction in the shape of Velia Hill which was 75 feet high. The latter operation, alone, involved the excavating of about 327,000 cubic yards of material—a compacted mass of earth and rock that resisted removal by ordinary means. Furthermore, the use of explosives was prohibited for fear of damaging the ancient monuments paralleling both sides of the right of way and, also, to safeguard life.

As can be appreciated, this preliminary work was more or less of an archaeological nature and necessitated the exercise of great care. It was possible to do this and yet not delay operations by the employment of CC-45 pneumatic paving breakers, of which there were more than 30 on the job. These were supplied with air by ten 5½x5-inch Type Twenty portable compressors. With this equipment the area was cleared of an enormous amount of material—consisting largely of rock, brick, and an exceptionally hard concrete containing fragments of stone, tuff, and marble—within eight months and without impairing any of the Roman remains. It might be remarked here that, in laying out their plans, the commissioners had to be guided entirely by those structures and ruins, as it was stipulated that not one of them was to be demolished either in whole or in part in carrying out the program of city improvement and expansion. It is therefore worthy of note that the excavators not only have brought to full view much of historic value that was heretofore hidden by surrounding



ANCIENT REMAINS

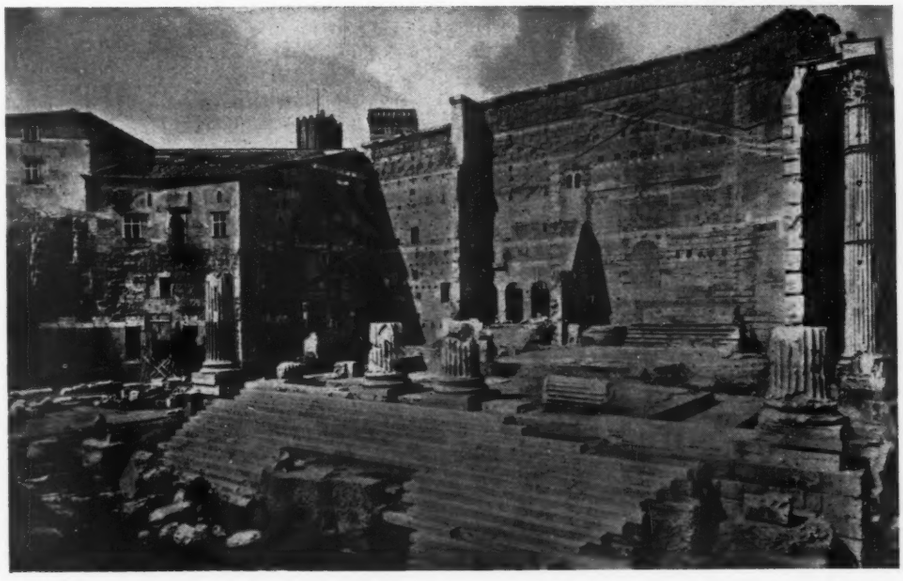
were unearthed here and there by the excavators who used pneumatic paving breakers and portable compressors (left) so that the work could be done both quickly and carefully. Trajan's Market (center) is one of the most interesting sights along the Via dell'Impero. It was uncovered only a few years ago and is so sound structurally that it is utilized today on festive occasions. The superimposed buildings are of a later period. Ruins of the temple of Mars Ultor in the Forum of Augustus (bottom) with what is left of the 100-foot-high wall that once surrounded the area dedicated to the god of war.

and superimposed, ofttimes squalid, buildings but have actually unearthed stonework of the remote past the existence of which was unknown. Outstanding among the monuments of the former class are the forums of Caesar and Augustus. These have been uncovered and restored as much as possible.

What has been said about the Via dell' Impero also applies in large measure to the Via del Mare—the Way of the Sea. This highway forms a connecting link between the Piazza Venezia and Ostia, the "Lido" of Rome. It skirts Tarpeian Rock—from which, so history tells us, condemned traitors were hurled to their death in the ages gone—and the Theater of Marcellus, terminating at the Via Bocca della Veritá. From there the route leads to and along the Tiber and thence to the Basilica of St. Paul, from which point it is but a quarter of an hour's run over the Via Ostiense, a new motor speedway, to the seaside resort.

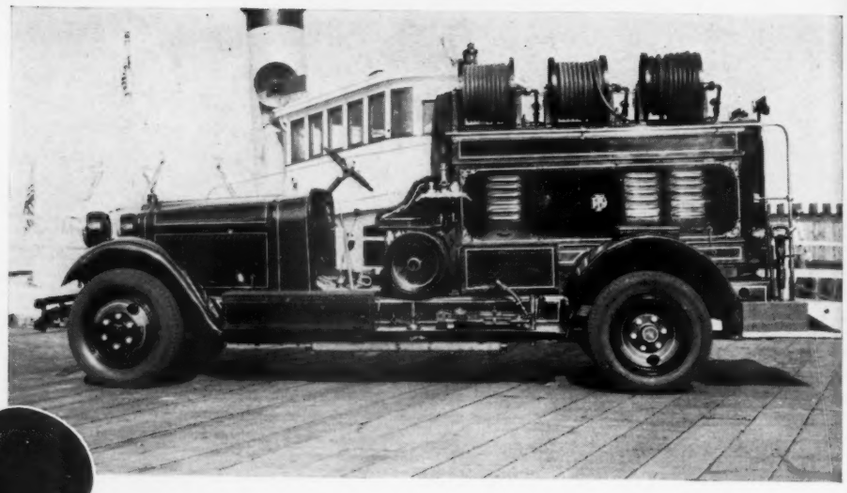
Persons who know Rome but who have not visited the capital recently will be amazed at the changes it has undergone since the 5-year plan went into effect. Annually during that period a sum of 30,000,000 lira (at the present rate of exchange a lira is equivalent to $0.05263 in United States currency) is being spent on a wide variety of public works. For the people who lived in the old section, taken over by the government for roadbuilding, attractive homes have been provided; and lands are being reclaimed that will add 22,240 acres to the city, enough to accommodate many thousands of its now crowded populace. In short, a new Rome is making its appearance—a spacious, beautiful city that, despite modernization in keeping with present-day demands, will still be distinctively Rome because antiquity is not being made to give way to utility.

The members of the commission to whom credit is due for the plan are: Messrs. Bazzani, Brasini, Paribeni, Piacentini, Del Bufalo, Calza Bini, Giovannini, Salatino, Palazzo, and Munoz.



Fire-Fighting at Its Best—

LAWRENCE A. LUTHER



CHANGING METHODS

Modern building construction has necessitated numerous additions to fire-fighting equipment, and portable air compressors and accessory tools are proving valuable aids in various cities. Concrete and metal barriers against which the hand-wielded axe is of little avail frequently block the fireman's paths, and it is at such times that air-driven tools are called into play. The pictures above were made in San Francisco. At the top is a truck-mounted Type 20 compressor, specially built to carry reels of air hose and a complete complement of tools. In the central and bottom views firemen are demonstrating how an air-operated saw and a clay digger equipped with a chisel can speedily cut through 4-inch planking.

MONEY was scarce in San Francisco, Calif., in 1849, but nuggets and yellow dust were not, and hoarding had not become a besetting sin among our Westerners. One of the least admirable proclivities of the bearded, booted miners who came down with full pokes from the diggings to see and to celebrate was the tendency to start fires. Only a few of the celebrants were malicious; but to the majority, life—like gold—was treasure to be spent lavishly and with gusto. Wood stoves and oil lamps in resorts on what later became San Francisco's "Barbary Coast" often failed to survive their exuberance. On December 24, 1849, in the first of a series of devastating fires, the most valuable single piece of property then in the city was destroyed—the Parker House, which collected annual rentals to the amount of $60,000 from various gambling establishments.

On Christmas morning of "forty-nine," the first fire department was organized under the leadership of Mayor Kearney. Three privately owned engines, all manually drawn and operated, were the nucleus of the equipment. The sea was sometimes a determining factor in fighting a fire, as the supply of fresh water was entirely controlled by a Mr. Putnam who, with a delivery service consisting of two mules and eight kegs, provided the town with water at ten cents a gallon or twenty-five cents a keg. That this first department fought against unbeatable odds is evidenced by records of several exceptionally persistent merchants who rebuilt their establishments five and even six times. No insurance was written in San Francisco until 1853: the risks on flimsy, wooden structures were too great to be assumed. Numerous volunteer fire companies were formed; and these, when superseded by a paid department in 1866, had a total enlistment of nearly 1,000 men.

The great fire of 1906 remains a terrible and vivid memory with many residents. Reconstruction of the city with superior buildings did not by any means solve the problems of fire prevention and control. Many highly inflammable docks and waterfront structures, combined with the winds which blow more or less continually in the bay area, served somewhat to complicate the work of the fire department.

After that devastating catastrophe, the residents of the ruined city began earnestly to seek some means by which, as far as it lay within human power, a recurrence of the disaster might be prevented. Falling back, as in the old days of hand-driven pumps, on the sea as a source of inexhaustible supply, a high-pressure system was devised with independent mains serving the waterfront and principal business districts. Two large standby pumping plants, capable of developing heads as high as 350 pounds, were completed in 1912. Steam pressure is constantly maintained in one group of boilers in each plant; and in the case of a severe fire, necessitating turning in three alarms, all boilers are fired and the plants made ready to augment the regular supply with water at pressures requiring no pumping at the hydrants.

To assist in the routine maintenance of this fire-fighting system, an 8x6-inch Type 20 air compressor on a rubber-tired mounting was purchased in 1926. It was typical of this forward-looking department that it should have grasped at any suggested means that would make it possible for the firemen to do mechanically and therefore more speedily some of the tasks ordinarily performed by them by hand. Time being more vital to success in this work than in any other, it was estimated that the saving of even a little in bringing water to bear on fires would soon compensate for any reasonable investment in such equipment. The tasks especially in mind

were cutting through floors and walls of concrete or brick and the plank decks of docks which are frequently paved with mastic.

The service demanded that any power tools utilized should be light, powerful, impervious to water, and proof against the ordinary hazards of fire-fighting. A cue was taken from the experience had in the department's maintenance work; and compressed air was selected as the medium most suitable for their operation. The aforementioned compressor was, therefore, hauled to several fires, and, proving its usefulness, was mounted on a truck body and included in the regular fire-fighting equipment.

The portable was fitted with an electric self-starter and housed in a special cab. Three large hose reels with ¾-inch hose were mounted on top, and special racks and boxes, in readily accessible positions, were provided for the various tools of Ingersoll-Rand make which now include the following: Two CC-45 paving breakers for cutting through sidewalks or cement floors, and a smaller breaker, a CA-35, for penetrating walls or ceilings. Two No. 73 diggers are carried for lighter demolition work or for work in close quarters. When equipped with special chisels, these tools will cut through steel window sash or through fire doors which cannot be unlocked. A T-handle digger, a No. 158 fitted with a spade, is used for excavating in earth; and a Size B-12 pneumatic circular saw cuts at high speed through plank decks or through other heavy wooden floors or walls. When provided with chisels, several of the reciprocating tools are suitable for these operations.

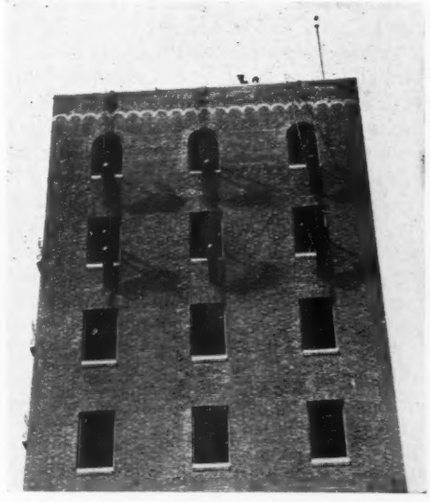
The field for the compressor has been gradually expanded as ingenuity and experience have suggested new applications. The considerable volume of high-pressure air that it makes available has on several occasions enabled men to work in unventilated places or has served to clear confined spaces of ammonia fumes or other harmful gases escaping from damaged piping or machinery. The unit has been called out to expedite the removal of gases not incidental to fires; and several drills have been staged to show how it could be used to supply air through connecting hose lines to men entering rooms in banks charged with tear gas. The machine is equipped with a pressure-regulating valve of the diaphragm type capable of speedy and accurate adjustment.

At the present time the department is working in collaboration with the U. S. Bureau of Mines on the problem of delivering low-pressure air to masks worn by firemen. If feasible, this would make the portable a valuable accessory to the rescue squad when engaged in difficult or extended operations in such restricted spaces as gas-filled basements, sewers, the holds of vessels, etc. Occasionally, the burning of large quantities of various substances will produce an impenetrable smoke or fumes that envelop the site of the fire and spread for a considerable distance. In cases like this the department visualizes utilizing the compressor as a source of a plentiful supply of fresh air that would enable men to get within striking distance of the blaze. The machine would be operated at a point far enough away to insure clean air—purity and proper temperature being further safeguarded by passing the air through a filter before it is fed to the masks.

While the foregoing is a potential field of service, we have an instance of this portable power plant's adaptability in the following work that is now regularly assigned to it—work in connection with steam-driven equipment that was formerly done by steam. In short, compressed air plays a helpful part in refiring the boilers of the municipal fireboats subsequent to their periodic overhauling. In the past it was the practice to refire with wood, which took several hours. Now oil is utilized instead; and air under pressure serves to effect the requisite atomization of the oil and also to run pumps when necessary—the compressor covering the call, from the time of leaving the home station until it returns, in a period as short as 45 minutes. In the event of fire while one of the two boats is undergoing repair, this decrease in the time required to get it back under steam so as to be ready to meet an emergency would represent a definite increase in the value of the marine fire-fighting equipment as a protective agency. The unit is assigned to a centrally located station so that it can respond quickly and supplement apparatus operating in any section of the city.

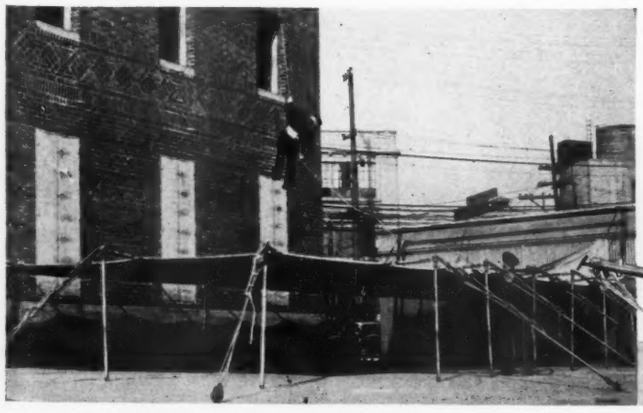
This article would not be complete if something were not said about the training of the firemen, another evidence of the present management's initiative. Recruits are given manual drills daily by a drill master; and a special 8-story drill tower has been constructed to assist in this work. They must also attend classes, where they are made familiar with fire-fighting equipment and sprinkler and alarm systems, and where they receive instruction in the methods of fire-fighting. Not until the men have had at least six months of this intensive training and have acquired proficiency as well as essential coolness and poise are they assigned to the hazardous and responsible duties of firemen. An admirable feature of this "university of firemen" is the practice of having men from the regular service come in at intervals for instruction and drill. This amounts to a sort of post-graduate course. In fact, the entire force is kept right up to the minute on the latest developments in apparatus and methods; and all the companies throughout the city are well qualified to coöperate in coping with big fires.

The author is indebted to Charles J. Brennan, chief engineer, Samuel Bermingham, superintendent of equipment, and to other officers of the department for much of the information contained in this article.



AERIAL GYMNASTS AND A VETERAN TRUCK

Two of the accompanying views show San Francisco firemen in their training maneuvers. At the right six men are practicing on scaling ladders high above the street. The fireman below is nearing the landing net after dropping on a rope from an 8-story height. In years gone hand-operated pumping engines were made in the East and shipped around the Horn to the Pacific Coast. One of these outmoded pumpers is shown at the right.



Unique Uniquity

FRANK RICHARDS

Editor's Note: This article was the final work of Mr. Richards, late associate editor of Compressed Air Magazine and for 26 years a member of its editorial staff. He wrote it when 94 years old, and it came to us a few weeks before his death. An account of Mr. Richards's life appears on the following page.

UNIQUE is the word uniquely unique. It either is or it is not; and, as everybody knows, does not permit of comparison or compromise, and yet may we not immediately say that New York is the most unique city in the world in that it is unique not in one but in many particulars? And wherein it is unique, the facts may be stated in the simplest terms with no fear of question and with no suggestion of boasting or laudation.

The immediately striking uniquity of New York is in its long bridges. It is one of the world's bridge cities. And then there is at once a twin uniquity in its tunnels both under its two rivers and in its network of subways, to say nothing of the bridges and tunnels yet to come. New York is unique again as the Skyscraper City, in both the number and the altitudes attained. And then, when, a little farther along, we come to consider the skyscraper and what it is doing, we may find that it has a special uniquity of function capable of conferring upon New York a uniquity of notoriety not yet recognized.

We might say that the New York skyscraper just happened and was never thoughtfully and functionally planned from the beginning. A man with winning business methods built the tallest building in the city, and it immediately advertised not only its builder but, still more, itself, and skyscrapers started with a jump. One of the most striking exhibits in the later growth of our metropolis has been the rapid erection of the towering office buildings, the latest surpassing its predecessor in magnitude and capacity. That they are remunerative is evident from their rapid multiplication; and their effective catering to the growing needs of active business must be conceded. The inquiry may now be made at any time: "What could we do without them?"

But besides the skyscrapers which legitimate business demands and located mostly south of the middle of Manhattan, there are those of a distinctively different class and function which are beginning to outnumber the others and are spreading all over the island and its associate boroughs—the towering strictly residential structures which are becoming the pride and the boast of the overgrown city. It may be asked, what is there in them to boast of? And how long can the exultation continue? What is now celebrity must later become notoriety, and we may know a great chagrin.

Say that the money which has been spent in the erecting and furnishing and equipping of those caravanseries had been otherwise expended. Say that it had been put into houses that were true homes; and in the suburbs there are spaces enough begging for them. Remembering the classes who are addicted to the apartment habit—not the wage earners but those who hold themselves higher, remembering that in the real houses and the true homes which would satisfy these higher classes there must be broad and generous surroundings comporting with their style and involving liberal expenditures throughout, the amount which it would have been imperative to spend would have gone very directly to the purchase of manufactures, to the support of the producers of the land. There are single buildings which advertise rooms to the number of 2,000 and over, divided up into ones and twos and threes to an apartment. While we enumerate what the campers-out in these rooms can have it will be well also to count up what they cannot have.

Not long ago one of New York's high-class hotels facing Central Park was pulled down to give place to a typical non-consumer's barracks 45 stories high, and this was immediately followed by another near it a little more pretentious. There are others scattered about too numerous to particularize accentuating the city's skyline. We may be very sure that a genuine and perfect and complete American home will never be found in either of these or in any other skyscraper. Just think of a home without a house!

This condition cannot long continue. Its malignant incongruity is not to be ignored; and already a worker strong and active with a notable uniquity of achievement is not only showing us the way but is actually preparing the road. Engineering is unique among the professions. The engineer does not try to do but he does; and of none of the other professions can this be said. The clergymen, the lawyers, the physicians work as hard in their several ways with a skill as deserving of respect, and they fairly earn their honors; but the results of their labors can none of them be characterized as certain and enduring and precisely predictable beforehand, and in general they do not even admit of measurement or comparison. Some of them can be called either a success or a failure, according to the viewpoint. Engineering failures are unknown. What the engineer plans and undertakes is certain of successful completion so far as the doing of it is entirely in his own hands, and the world has the confirmed habit of trusting him implicitly notwithstanding that the tasks he undertakes are continually growing in magnitude, requiring the satisfying of conditions more exacting and often unheard of before. The East River bridges were regarded for more than a generation as practically the limit for the suspension type of bridge, or indeed close to the limit for a bridge of any possible design, and even the extension of the suspension limit by a paltry 50 yards in the Delaware River Bridge brought world-wide glorification to engineering; but there was never a doubt or the slightest question as to its completion although its dimensions and capacities exceeded the traditional limit.

Perhaps one of the most astounding demands ever made upon the engineer was that to which he lately and so completely responded. Not by successive enticing little increments as heretofore in bridge building but by a single leap of the constructive imagination, confirmed by deliberate determination, the epochal span of the Philadelphia bridge was all at once doubled by the George Washington Bridge, and thousands of tons of traffic are daily proving its capacity. The bridge at Philadelphia has a clear span of 1,750 feet, lacking only 10 feet of one-third of a mile, while the span of the new bridge is exactly double this—3,500 feet or very close to two-thirds of a mile.

The marvel of the age is perhaps no greater in the engineer's undertaking of this stupendous task than in the unhesitating confidence of the civilized world in its complete fulfillment. The engineer said that he could and would build that bridge, and it is actually completed. And so it goes. Whatever may be demanded, when we have the engineer's responsible assurance, there is nothing more to be said and there are no lurking uncertainties. Whatever the engineer may successively accomplish beyond anything he has already achieved, the latest is never the last, and greater wonders are still to be wrought exceeding in some particulars all that has already gone upon record.

The case of the engineer is not that of a man seeking a job, but of the job seeking the man—and finding him. He was apparently the first to realize that we must spread out

BROOKLYN BRIDGE

instead of climb up. Before the building of the big bridge he had already built a tunnel to take some of the same traffic, and now vehicles traverse that Holland Tunnel at a rate exceeding 1,000,000 per month. Another Hudson River bridge is to be built—let us call it the Lincoln Bridge, and there are additional tunnels planned and waiting for both the North and the East rivers; and then there is the Staten Island problem. Here is the city's great White Elephant, old but not venerable. It is the one persistent disappointment and obstruction to the growth and outspreading of the great city so urgently needed and all because of the lack of free and sufficient facilities of traffic communication so easily possible to all the other boroughs.

The story of the development, or rather the non-development, and of the present status of the Borough of Richmond, which is Staten Island, is the great argument for adequate highway communication or its complete equivalent. The entire area of the island, it is to be remembered, is as valuable, as desirable for residences or for industry of any kind, as that of any of the boroughs, with a score of miles of the most desirable waterfront for shipping. Here 20 per cent of the total land area of Greater New York has a little over 2¼ per cent of the population, with less than 3¾ persons to the acre, while the number to the acre for the whole city, even with this borough included, is 32.36.

It is evident that with full and adequate connection of this borough with Manhattan and the others, these figures would rapidly and vastly change. The ultimate complete solution of the problem is inevitable, and we think, of course, of a bridge across The Narrows; and we may be sure that the engineer would be delighted to put the bridge there with only a little longer reach, if any, than that of the bridge last completed. But at the present stage of the world's civilization it cannot be considered. To give anybody the chance to drop the bridge into the channel and to cork up the harbor is not to be thought of. Our highway must be a low-way. We will want a Holland tunnel and several of them paralleling to secure capacity—a very simple job except for the planning as to location, etc.

And this will not be the ending but rather near the beginning of a stupendous work. The fundamental plan of the great city will be automatically rearranging itself. The metropolis, we must believe, will continue to more than hold its own in dignity and importance but with changing details of occupancy and arrangement, its now least valued portions acquiring new importance. The Borough of Richmond, as an integral and active member of the great organism, will find itself already well equipped for the spreading out, having ready facilities for highway traffic to the south and west and, toward the latter, a new record-bearing bridge by the modern engineer with the longest span in the world for that type of construction. Compressed air will of course again have its chance.

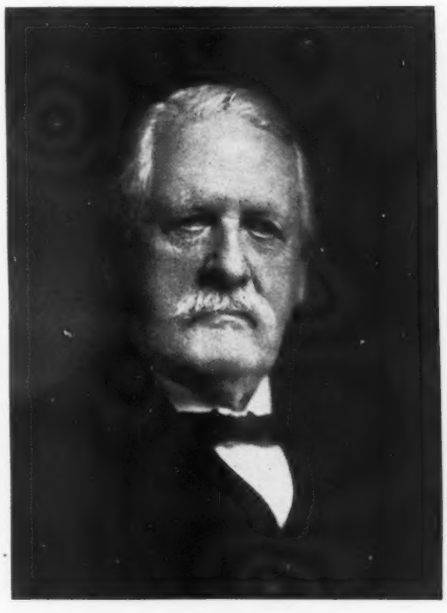
FRANK RICHARDS

FRANK Richards, associate editor of COMPRESSED AIR MAGAZINE and the author of several books on pneumatics, died at North Plainfield, N. J., May 21 at the age of more than 94 years. He was born at Taunton, in the south of England, February 10, 1839. It is a coincidence that his birthplace and the city in which he died, although on different continents, are both in Somerset County.

Visibl evidence of the energy and alertness of mind that were his almost until the last is given in the foregoing article which he sent to the office about two weeks before his death, having typed it himself. He purchased and learned to use a typewriter when nearing his ninetieth year.

Mr. Richards spent most of his life either working with machinery or writing about it and its applications. As a lad of ten he came to this country with his father, who had been a manufacturer of heavy machinery in England. The elder Richards opened a plant at Plattsburgh, N. Y., and it was there that the son gained his first shop experience. In following years Frank Richards worked for various machinery manufacturers, among them Starbuck Brothers and Tolhurst Company, both of Troy, N. Y. After residing in various New York towns, he went to New York City in 1889 to become superintendent of the shops of the Ingersoll-Sergeant Rock Drill Company, then located at 27th Street and 9th Avenue. He remained there four years, leaving upon the occasion of a change in the ownership of this concern which, later, was consolidated with others to form the present Ingersoll-Rand Company.

For many years previous to that time Mr. Richards had been a contributor to *American Machinist*, and when he was offered the position of assistant editor on this magazine he accepted the post and held it for ten years. Incidentally, his writing activity led him to change his Christian name. He was baptized Francis Henry Richards, a name which happened to be possessed also by another writer for *American Machinist*—a prominent engineer and inventor who died in April just past. To end the confusion resulting from two men of the same name contributing articles to the same publication, Mr. Richards adopted the name of Frank, and was thereafter known as Frank Richards. He also wrote on machinery topics under the pen name of Tecumseh Swift. His reason for choosing the last part of this name is obscure, but he took the Tecumseh from the name of Gen. William Tecumseh Sherman whom he admired greatly and whose birthday fell on a date only two days from his own. He could recite the names of various prominent personages whose birthday anniversaries were close to his; and it is significant that in the accompanying article he makes mention of one of them—Lincoln.



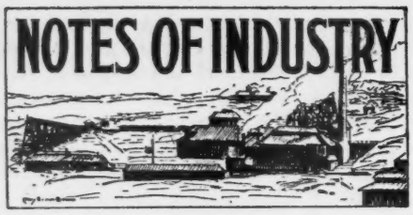
FRANK RICHARDS

In July, 1907, Mr. Richards became managing editor of COMPRESSED AIR, as this publication was then known. After twelve years in that capacity and brief service as technical editor he was made associate editor in October, 1920, and continued as such until his death. Because of his advanced age, he had not been actively engaged on the magazine for several years, Much against his will, he was induced to retire in 1927, not because his brain or eye had been dimmed by the passing years but because his associates feared that some accident might befall him on the way to and from his work. For, even though he was nearing ninety, he punctually commuted to New York each morning and walked the dozen blocks or so from the ferry to the office.

A sense of humor, betokened by a twinkling eye, was one of Mr. Richards's outstanding traits. He was a serious worker, extremely painstaking in his writing, but his buoyant nature was always cropping out. He was a lover of good literature, and his agile mind could produce a quotation apropos of almost any situation. For many years, while he was in New York, it was his custom to spend part of his noon hour browsing around the bookshops, seeking additions to his well-stocked library.

The pages of COMPRESSED AIR MAGAZINE have contained countless articles by Mr. Richards. His best-known book is *Compressed Air Practice*, a work which is still found helpful by many engineers. Mr. Richards was a member of the American Society of Mechanical Engineers.

Mr. Richards's wife died in New York in 1921, after they had been married 55 years. Not long after that he took up his residence in North Plainfield with his son, Frederick H. Richards. The latter and his wife survive him. Other survivors are a grand-daughter, Mrs. George Reynolds of Troy, and three great-grandchildren. A daughter, Mrs. L. S. de Zouche, died in March of 1932.



In Brazil is found a rock that bends. It is a sandstone technically called *itacolumite.* Scientists attribute its flexibility to its porous structure.

Smokers may or may not know that attar of roses, a perfume oil of quality, is used in flavoring—or should we say scenting—tobacco. That probably accounts for the fact that some "segars" have more bouquet than others.

Karl Zeiss, of the well-known German firm of optical-instrument makers, has developed an illuminated extension telescope for examining or inspecting the inside walls of pipes, tubes, or containers that are too restricted in size to permit access or too dangerous for workmen to enter.

Bucyrus-Erie Company, South Milwaukee, Wis., is distributing a bulletin describing a new 16-B ½-yard shovel, dragline, crane, clamshell, dragshovel, and skimmer scoop which is designed to meet the prevailing demand for low-cost excavation and material handling.

Nearly half as much quicksilver as the United States buys in an average year, or enough to make 50,000,000 thermometers, has been used by the General Electric Company in the construction of the 20,000-kw. mercury turbine now installed in the Kearny plant of the Public Service Corporation of New Jersey.

A full line of portable cords and cables provided with a special outer sheath that is impervious to the destructive action of oil and grease has been developed by The Okonite Company of Passaic, N. J. Oilproof Okocord, as it is named, is also little affected by strong sunlight or ozone, giving it a wide field of application both indoors and outdoors.

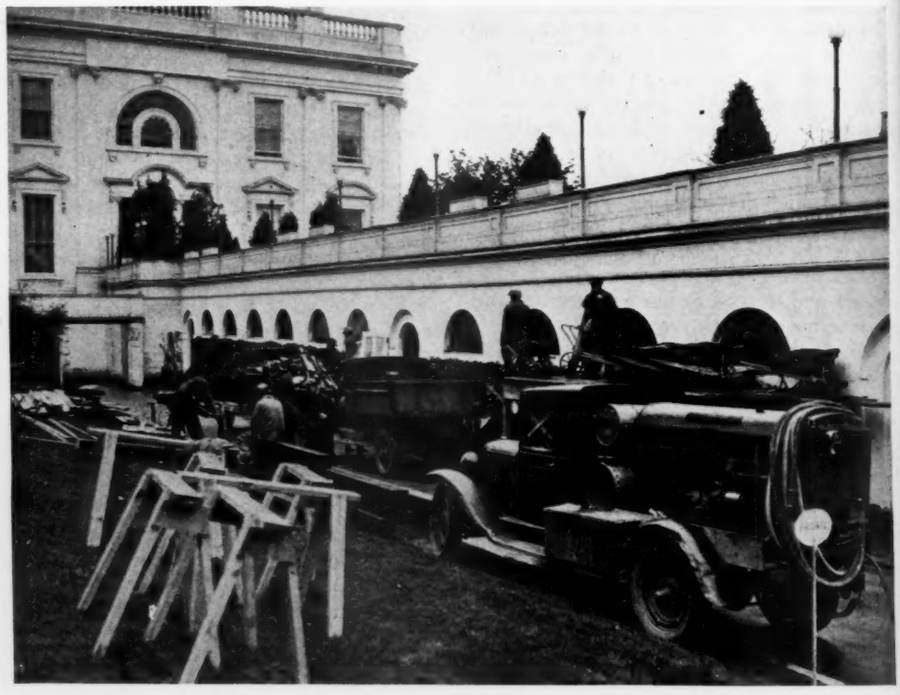
Metal window panes that have all the advantages and none of the disadvantages of glass are, we are reliably informed, being manufactured in Germany. Aluminum is the mineral used, and is converted by a special process into transparent sheets that are well suited for glazing roofs, skylights, and windows generally, and for making all sorts of household utensils.

Silver is being utilized to sterilize drinking water, reports the Department of Commerce, which goes on to say that a portable filter so charged has been developed in Germany, where it is attracting much attention. The filter is designed for household use and for the traveler, and has a capacity of 250,000 gallons, or enough to supply the average family with potable water for a long time without the need of new parts and attention. The process is said to be applicable also to water works, ice plants, pools, or other consumers of large quantities of water.

Hercules Powder Company, Wilmington, Del., has issued an 80-page booklet, *Accelerating Swamp Fill Settlement with Explosives.* It brings together in one compact volume data on all known successful methods of fill settlement, and supplements the descriptions with diagrams and photographs. It also tabulates costs. The book is designed for use as a field guide for determining the most effective method of fill settlement in a given location and for putting the method into operation. Highway engineers may obtain a copy without cost to them by addressing the issuing company.

There is a very wide gap between the largest and the smallest incandescent lamp now made by the General Electric Company. The latest addition to the family is the 3-watt, 110- to 120-volt bulb, which has a maximum diameter of ¾ inch and a length of 1⅞ inches. Contrast this with the head of the group, the 50,000-watt lamp, which burns as much current as would 16,666 of the little fellows. The latter make excellent night lights; and also serve a very useful purpose in illuminating house numbers, name plates, door bells, electric-light buttons—in fact, are designed to prevent fumbling and stumbling around in the dark.

Paris, France, boasts a glass house, recently built, which is noteworthy because, with the exception of the doors, it is hermetically sealed. Three sides of the structure have double walls of glass which keep out exterior noises and between which heated air will be circulated in winter and chilled air in summer so as to maintain the rooms within at a constant and comfortable temperature at all times. Ventilation of the house itself will be effected by the use of filtered air. The building is supported by numerous concrete piles which reach from the foundation to the roof. Before work on the structure was undertaken, both the type of construction and the heating, cooling, and ventilating systems were made the objects of experiment by the St. Gobain Glassworks.



Acme Photo.

BUILDING WHITE HOUSE SWIMMING POOL

The accompanying view shows work in progress at the White House at the time the excavation was being made by the Office of Public Buildings and Public Parks for the new swimming pool recently constructed for President Roosevelt's use. The cost, estimated at $20,000, was defrayed by public subscription, and the gift was formally accepted by resolution of Congress.

The tank is located in a wing of the White House that is about 120 years old and that has been used at various times for such widely differing purposes as a stable, greenhouse, slave quarters, maids' bedroom, laundry, and offices. The walls extended only 2 feet below ground level, and it was necessary to underpin approximately 150 feet of them to a depth of from 6 to 10 feet before excavating within the building for the pool. Air-operated pavement breakers were used to rip up the flooring and clay diggers for loosening the 300 cubic yards of earth that had to be removed.

The tank has a capacity of 35,000 gallons, measures 15x50 feet, and is 9 feet deep. Adjacent to it are two small dressing rooms and shower baths. The water will be maintained at a uniform temperature by thermostatic control, and filters will permit it to be recirculated.